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USSR Report

SPACE

No. 14



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SPACE SCIENCES

COMMENTARY ON SOVIET-FRENCH 'AUREOLE-3' SATELLITE

Moscow IZVESTIYA in Russian 24 Sep 81 p 3

[Article by IZVESTIYA science reviewer B. Konovalov: "Toward the Solar Wind"]

[Excerpt] Soviet and French scientists joined forces a long time ago in solving a problem important to all mankind--the problem of sun-earth relationships. The next important step in seeking out the threads of the puzzle has now been taken. From a Soviet cosmodrome a powerful rocket has borne into orbit the "Aureole-3" satellite developed by Soviet and French specialists. Its primary purpose is to study the process of energy transfer from sun to earth, an investigation of the interrelationship of phenomena in the magnetosphere and the ionosphere of our planet. The satellite's elliptical orbit from 400 to 2000 kilometers high covers the highly geosynchronous polar "caps" of the earth with observations.

"Aureole-3" was developed on the basis of the Soviet AUOS (automatic universal orbital station) series of satellites, which are widely used in the "Intercosmos" program. It carries a large complement of instruments with a total weight of about 200 kilograms. Half of them are Soviet and half are French.

Each instrument is doing its job. For instance, there are sensitive instruments which register magnetic and electrical fields, both constant and variable. This is an important area of research because magnetic and electric fields are always accompanied by phenomena associated with the transfer of energy from sun to earth. Moreover, they themselves influence those mechanisms which develop here.

A series of instruments aided by various detectors will measure fluxes of low, medium and high energy particles in near-earth space by separating the various components of corpuscular radiation--electrons, protons and heavier nuclei. Studying this "population" of near-earth space, understanding how it is replenished from the sun and the universe, and explaining how its composition and behavior vary are very important in finding the key to the mechanism of sun-earth relationships.

No less important, too, is the in-depth study of the nature of variations in fluxes of electromagnetic radiation, particularly its variable shortwave component which relates very closely to the state of our star. There are for this purpose instruments which will measure fluxes of energy in the X-ray, ultraviolet, visible and near infrared ranges. These instruments, combined under the general designation

"electrospectrophotometers", are multichannel instruments as a rule. Each band of electromagnetic radiation is separated into individual spectral segments.

This arsenal of instruments, in contrast to the earlier experiments under the "Arcade" project, will make it possible to obtain a complex of data characterizing the state of matter at every point on the satellite's orbit. The researchers now have an opportunity to determine the mass composition of the particles, the distribution of their energies and direction of the energy fluxes, and to record the wavelength of the detected radiation, the frequency spectrum--the magnetic and electric fields in absolute magnitude and direction at each moment of time.

A remarkable technical feature of the new scientific satellite is the on-board microcomputer developed by French specialists. It collects information from the numerous sensors (about 30 of them), does preliminary processing, as if condensing it, and then distributes it in digital form over the communications channels for transmission to the ground. In addition, the machine can perform individual scientific-instrument-control functions.

Besides the usual ground-based facilities for receiving space information, there will be in operation during the "Aureole- 3" experiment several special centers for reception of the scientific information: three Soviet--in Noril'sk, Kirovsk and Tarus, and five French--in Toulouse, Kourou (French Guiana), Tromsø (Norway), Kerguelen Island (Indian Ocean), and Adélie Coast (Antarctica). All the information will be transmitted to the Institute of Space Research of the USSR Academy of Sciences and, in France, to CNES (National Center for Space Studies).

Before the launch our correspondent discussed with French scientists the value of the "Arcade" project and USSR-French cooperation in the study of space.

Said Professor Francis Cambou, "I first went to Moscow on a business contact with Soviet scientists 13 years ago. At that time we organized initial joint observations with balloons. The thread of close collaboration has not been broken since. This simple fact alone attests to its fruitfulness. I always enjoy a meeting with my Soviet colleagues. They invariably run amicably, in the fine atmosphere of scientific pursuit."

"I have worked for somewhat less time with the Soviet colleagues--10 years in all," continues Professor Henri Rem, "and I want to emphasize the mutual advantageousness of Soviet-French space collaboration which allows us to accomplish ever more complex and meaningful experiments. We started with balloons and have now gotten up to a very complex satellite. In the earlier 'Aureole-1' and 'Aureole-2' experiments we found out much that was new about the auroral zone of our planet by studying upper atmosphere luminescence. Now the spectrum of studies of the magnetosphere and the ionosphere is being greatly expanded. It is to be noted that a French computer will fly aboard a satellite for the first time. Behind are 7 years of joint work. In my opinion, both the French and the Soviet sides have learned much in the course of realizing the project. We were always satisfied with the results of the earlier operations and we expect a lot from the new joint experiment."

Professor Jean-Claude Jusson, general director of the CNES Toulouse space center states: "Soviet-French space collaboration has been going on now for some 15 years.

That's a tremendous length of time! We are happy with past progress and are confident that fine prospects are in store for us. The scope of the collaboration has now been broadened--a joint space flight is coming up with a French astronaut participating. Two French pilots are being trained for the flight at Zvezdnyy Gorodok. During the summer they were in France. They trained in fighter aircraft and learned to work with equipment which will be occupying its work site on the "Salyut" orbital station at a future time.

"Both are in fine shape, full of energy. At a hospital in Toulouse they tested a number of medical instruments they'll have to work with in space. Another important area to which we are devoting serious attention is space materials technology. The 'El'ma' joint Soviet-French experiments in space technology were performed aboard "Salyut-6" earlier. Now we are preparing new equipment which will fly with the French astronaut.

"But now, of course, the 'Aureole-3' is the focus of interest. It is considerably more complex than the Soviet-French 'Sneg-3' which was launched 3 years ago from a Soviet cosmodrome. We hope the joint operation is fruitful; we anticipate interesting results from this project."

"The Soviet scientists also are satisfied with the course of the joint operations with the French colleagues," says Vyacheslav Mikhaylovich Balebanov, deputy director of the Institute of Space Research of the USSR Academy of Sciences. "'Aureole-3' is a shining example of the fruitfulness of combining forces in the investigation of space. We gain mutual profit from the joint work. Our star has now passed the peak of an 11-year cycle of solar activity. And it is very interesting to watch the dynamics of the processes going on in near-earth space during a decline in solar activity. Unusual opportunities are opened up to researchers at this time. Simultaneously with the 'Aureole-3', the Soviet-Bulgarian 'Intercosmos-Bulgaria 1300' satellite and the American 'Dynamics Explorer' spacecraft are working on about the same program in other orbits. It is therefore possible to obtain comprehensive information on various regions of circumterrestrial space at the same time. The exchange of data will enable science to gain a better understanding of the complex mechanism of sun-earth relationships."

Space is bringing peoples together. After the first satellite was launched, mankind came to realize how small is our planet which a spacecraft can circle in just an hour and a half, and how many yet unsolved problems exist which are equally important for all peoples of the earth. Hence, ever more often now the manmade stars in earth's sky are stars of friendship and collaboration. The union of different countries' efforts to solve global problems is to the advantage of all, and international projects in the mastery of space are taking on ever greater scope and popularity.

5454

CSO: 1866/12

COMMENTARY ON 'INTERCOSMOS-BULGARIA 1300' SATELLITE

Moscow IZVESTIYA in Russian 12 Aug 81 p 5

[Article by Kirill Serafimov, associate member of the Bulgarian Academy of Sciences, chairman of the National Committee for Exploration and Use of Outer Space: "Joint Research"]

[Text] Launch of the "Intercosmos-Bulgaria 1300" satellite is a great event in the life of our country. This brilliant space achievement is interwoven into the wreath of numerous accomplishments with which the new, socialist Bulgaria is observing the anniversary of the first Bulgarian state.

The Bulgaria-Soviet satellite was conceived by a group of enthusiasts striving to make an earnest contribution towards solving global scientific problems, to build a composite space laboratory for long-term and comprehensive study of near-earth space.

The basic purpose of the new satellite was to obtain data on the interaction between processes taking place in the magnetosphere and ionosphere. It is precisely here, in this region, where perhaps the most substantive--and, to a great extent, still unknown--portion of the vast sun-earth "bridge" is located. It is across this "bridge" that all changes in the activity of that star reach our planet and have a significant effect on the earth's geophysical processes and its biosphere. Streams of particles that drift to the earth--a kind of "solar wind"--are sharply intensified after powerful flashes on the sun (the energy released here is equivalent to an explosion of millions of hydrogen bombs), and this has an effect on geophysical, meteorological and climatic phenomena as well as being reflected in the health and work efficiency of individuals.

With the help of the satellite, scientists are hoping to be able to better understand the mechanism whereby solar disturbances are transmitted to the earth. This will enable us to predict more confidently the scope of effect of solar phenomena on various aspects of our life here on earth, and will have practical significance. On the other hand, the direct investigation of near-earth plasma will make it possible to study reactions, processes and phenomena that would be difficult to reproduce in laboratories on the earth.

In order to carry out the satellite's scientific program, a complex of original, modern instrumentation and equipment was built by academic and trade institutes and laboratories, and by the industry of the People's Republic of Bulgaria with the assist-

ance of Soviet experts. This complex can be divided into four groups. The first includes seven systems and instruments for studying electrons and ions in near-earth space, for determining their concentration and temperature, and their distribution according to energy and ion mass, for detecting flows of ionospheric plasma. The second group includes a system for determining permanent and varying electric fields, and a highly sensitive magnetometer. The third group contains an electro-photometer for determining weak emissions of light in the upper ionosphere, and a device for detecting and recording ultraviolet radiation. All of this instrumentation was built on the most modern technological level using the latest base for components and materials.

We devoted a great deal of attention to measurement accuracy. For the first time, the entire satellite surface, including the vacuum-shield thermal insulation and wings of the solar batteries, was completely covered with a thin, metallic film in order to eliminate accumulation of electrostatic charges on any part of the space vehicle. All of the sensing elements were on special rods, which opened out to a distance of four-five meters from the vehicle after satellite injection into orbit, so as to record the parameters of undisturbed plasma.

The fourth instrumentation group, the angular laser reflector, is in somewhat a class of its own with respect to the basic purpose of the satellite. It is assembled out of five panels that are joined in the form of an inverted pyramid, the truncated upper portion facing downwards towards the earth. Fastened to the bottom of the satellite, this reflector allows all earth stations equipped with laser sets to follow the satellite and accomplish a whole series of interesting tasks.

First of all, the coordinates of the earth stations will be determined with great accuracy and it will be possible to follow their reciprocal disposition. This is extremely important, since our satellite's angular reflector can be used to obtain new information on the movement of various regions of the earth's crust. The great degree of measurement precision allow us to study such delicate phenomena as non-uniformity in rotation of the earth, and we can trace the movement of our planet's poles. Another important purpose is the development of procedures for monitoring certain changes in the satellite's orbital parameters. We have hopes that using lasers for fixing location will permit us to determine the position of satellites in space with great accuracy--to within meters--and to predict their orbit.

The building of modern space instrumentation in Bulgaria was made possible thanks to the energetic scientific and technical development of our socialist country, and to the enormous progress achieved with respect to our electronics, electrical engineering and instrument manufacturing. No less important or cooperative has been the integration of our science and technology with that of the Soviets--pioneers in the space era and standard-bearers of progress.

Many times already, the great advantages of socialist integration have been clearly demonstrated in space. Our scientists and other experts had the opportunity here to use a Soviet space-rocket complex. Our cosmonaut on board a Soviet ship launched into near-earth orbit. We received invaluable assistance from our Soviet colleagues in making controlled measurements and in instrument calibration; we received essential materials and components from them.

Modern systems for energy supply, stabilization, orientation, telemetry and telecontrol were built for the new satellite in the Soviet Union. During all stages of the birth of the satellite--in the assembly shops and at the cosmodrome--experts in each of the fraternal countries worked shoulder to shoulder, in friendship and harmony, to overcome numerous difficulties.

The space project "Bulgaria 1300" consisted of two parts. A great deal of significance today is attached to space research with regard to the earth's natural resources, and to studying the mechanism of sun-earth links. But it was difficult to combine these two missions in one satellite. A solar-synchronous orbit is necessary for studying the earth's resources, so as to observe the same regions under identical illumination conditions, whereas geophysics research requires a polar orbit which encompasses the most geo-active regions. Therefore, the Bulgarian scientific equipment was mounted on two satellites--the Soviet "Meteor-Priroda" and the international "Intercosmos-Bulgaria 1300." We are fortunate that both satellites and the entire equipment complex has been functioning reliably. First-rate information from space is reaching both Sophia and Moscow.

I would like to take advantage of this opportunity to express my heartfelt thanks to all our Soviet colleagues who participated in this common project.

Certainly it is the rockets which put the satellites into the sky, but the wings of a close friendship between Bulgaria and the Soviet Union have done so as well. We rejoice that cooperation in space is serving to solidify even more the long-standing and sincere friendship between our brotherly peoples.

9768

CSO: 1866/160

FURTHER COMMENTARY ON 'INTERCOSMOS-BULGARIA 1300' SATELLITE

Yerevan KOMMUNIST in Russian 13 Sep 81 p 2

[APN article: "'Intercosmos-Bulgaria 1300' is Functioning"]

[Text] "Intercosmos-Bulgaria 1300" was launched into earth orbit on 7 August. At the request of APN correspondent Tat'yana Troitskaya, the president of the Armenian SSR Academy of Sciences, Andranik Iosifyan--its chief designer and Soviet scientific supervisor--talks about the spacecraft's operation.

The "Intercosmos-Bulgaria 1300" spacecraft was an important logical step in the extensive cycle of projects on the development of automatic space observatories begun 14 years ago. The first Soviet meteorological satellites appeared in the late sixties, tasked to solve one of science's most difficult problems--long-range weather forecasting.

The satellites' scientific apparatus made it possible to measure various thermal currents and to photograph the cloud and ice covers in visible and infrared light by day and by night. The state space meteorology system, "Meteor"--a USSR first--consisting of several satellites, proved itself well in photographing the earth's surface. In time, it began to provide accurate information on the condition of forests and crops, the movement of clouds and other natural phenomena. It is no wonder that today these satellites have been dubbed "Meteor-Nature" [Meteor Priroda]. They have a strong electric power system designed for a long active lifetime and, what is a prime consideration, they are distinguished by a high degree of stabilization and earth-orientation.

A fundamental complication in the case of meteorological satellites was that it was necessary to develop an automated spacecraft not requiring systematic control from the ground and able, throughout many months of oriented flight, to collect, store, and transmit to receiving points on the ground a large volume of information of national economic import. It is, in essence, a space robot-automaton, and such a robot was created. A feature of the whole complex is its high reliability, which ensures the years-long functioning of ac and dc electrical systems, electronic control units and solar batteries.

Specialists succeeded for the first time in using the earth's magnetic field in the electromagnetic actuating elements of the stabilization systems and in finding

ways to shield the complex electronic devices from interference, from pulsations and from the reciprocal effects of electromagnetic fields in the case of low-level useful signals.

In 1977, at one of the coordination meetings of the "Intercosmos" council, Bulgarian and Soviet specialists reached a decision on installing a number of devices developed by the Bulgarian Academy of Sciences aboard a Soviet "Meteor" satellite. The first "Meteor-Priroda" satellite carrying Bulgarian scientific apparatus has been in space for a long time now and is successfully carrying out the mission assigned to it.

"Intercosmos-Bulgaria 1300" is the second satellite to carry Bulgarian geophysical instruments. Its launching coincided with the 1300th anniversary of the founding of the Bulgarian state. The new spacecraft is called on to provide information about physical phenomena occurring in near-earth space. Electron-ion processes develop here which exert an energetic effect on the lower layers of the atmosphere and influence meteorological conditions.

The research program provides for study of the convection movements of ionospheric plasma and their relation to phenomena in other zones of the earth's magnetosphere and in interplanetary space. It also includes investigations of turbulence phenomena in the near-earth plasma, the detection and study of inhomogeneities in the ionospheric plasma and of dynamic links between the ionosphere and the magnetosphere.

Measurements are to be made at various orbit positions relative to the Earth-Sun line and during heightened solar activity. The rather high precision of the satellite's orientation will make it possible to obtain data of very high quality.

The collaborators were successful in ensuring total electromagnetic compatibility of all of the scientific satellite apparatus and high experiment fidelity. In particular, the Soviet specialists devised a very clever technical solution by developing a system of multiple-joint boom devices. By means of them, instruments can be positioned up to 5 meters away from the body of the satellite. Moreover, special coatings were developed and used for the first time on the body, the instruments and the solar batteries. The important scientific and technical problem of heat elimination from instruments operating in open space was also solved.

There are interesting features, too, respecting the system for collecting the scientific information, developed through joint efforts of the Soviet and Bulgarian specialists. Further joint experiments are proposed: in particular, continuation of investigations of the earth's natural resources and the provision of operational forecasting of earthquakes. Just as synoptic meteorologists today can't envision analysis of atmospheric processes without the employment of satellites, geophysicists, too, will begin, in the near future, to make use of highly precise satellite information about the phenomena occurring in the earth's crust. This information will have immense national economic value, especially with respect to the construction of electric power stations in areas of high seismic activity.

EQUATORIAL BOUNDARY OF HEAVY SPILLAGE OF MAGNETOSPHERIC PROTONS WITH $E_p > 0.5$ MeV

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 23 Feb 80) pp 401-408

POPELYAVSKA, B., VAKULOV, P. V., KUZNETSOV, S. N. and KUDELA, K.

[Abstract] Using data gathered by three semiconductor detectors on the "Inter-cosmos-5" satellite during six magnetic storms in December 1971 and January, February and March 1972, the authors try to determine the dependence of the equatorial boundary of the isotropic spillage of magnetospheric electrons with $E_p > 0.5$ MeV on the K_p index and mean local time. They indicate that there is a relationship between this boundary and the cutoff threshold for low-energy solar protons during magnetic flares. The proposition that the spillage of protons with $E_p > 0.5$ MeV takes place along the inner edge of the plasma layer seems to be confirmed by data gathered by the ISIS-2 satellite. Figures 4; references 24: 7 Russian, 17 Western.
[133-11746]

SPATIAL DISTRIBUTION OF PLASMA-LAYER ELECTRONS, ACCORDING TO MEASUREMENTS MADE BY 'RADUGA' SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 10 Apr 80)

GRAFODATSKIY, O. S., IL'IN, V. G., KANALEYEV, V. N., KNYAZEV, B. N., LAZAREV, V. I., MARKELOV, G. M., OSIPOS, N. K., SMOLIN, S. V. and TEL'TSOV, M. V.

[Abstract] The authors present the results of measurements of flow densities of electrons with energy levels of 0.5-5 keV by a satellite in a geostationary orbit under conditions of moderate magnetic activity and during a magnetically calm period. A cylindrical electrostatic analyzer was mounted on a "Raduga" satellite in such a fashion that it could register electrons with pitch angles of $\pm 70^\circ$. The measurements were made from July to September 1978. The conclusions reached on the basis of these measurements are: 1) the conditions for charging the nocturnal sector with plasma-layer electrons differ from those for the diurnal sector; 2) the explanation for this is the mechanism for plasma-layer electron transfer into the depths of the magnetosphere by large-scale convection; 3) the

changes in the position and configuration of the forbidden zones indicate that large-scale electrical fields display substantial variability when there is a transition from calm conditions to conditions of moderate magnetic activity.

Figures 3; references 4: 1 Russian, 3 Western.

[133-11746]

UDC 551.524.72:551.593.13:525.72

RECOVERING DENSITY PROFILE DISTURBANCES IN THE ATMOSPHERE FROM REFRACTION MEASUREMENTS MADE BY ARTIFICIAL EARTH SATELLITES

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 6, Jun 81 (manuscript received 18 Apr 80, after revision 12 Jun 80) pp 574-579

SOKOLOVSKIY, S. V., Institute of Physics of the Atmosphere, USSR Academy of Sciences

[Abstract] The author describes a method for recovering small-scale (of a thickness substantially less than the difference in the altitudes of the perigees of the upper and lower rays arriving at the observation point from the Sun) disturbances in the atmosphere's vertical density profile on the basis of the shape of the Sun's outline as seen through the atmosphere from artificial Earth satellites. He presents the mathematical apparatus used with a spherically symmetrical model of the air density profile and evaluates the accuracy of the method, which is about 10" in measurements of angles. The basic source of error is random error, the variance and correlation distance of which can be regarded as constant. Figures 3; references 4: 2 Russian, 2 Western.

[142-11746]

UDC 524.35

GAMMA-SURGES OF 13 AND 23 OCTOBER 1978 AND 7 JANUARY 1979

Moscow PIS'MA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 7, No 6, Jun 81 (manuscript received 13 Feb 81) pp 342-346

D'YACHKOV, A. V. and ZENCHENKO, V. M., Institute of Space Research, USSR Academy of Sciences, Moscow

[Abstract] The surges of 13 and 23 October 1978 were registered by the "Konus" instrument on the "Venera-11" automatic interplanetary station and the "SNEG-2M3" instrument on the "Venera-12," while the surge of 7 January 1979 was registered by the "Venera-11" and the "SNEG-2MP" instrument on the "Prognoz-7" station. No other spacecraft registered these bursts because they were at the lower limit of registration of these extremely sensitive instruments. The authors present information on the time, localization and energy output of the surges, but cannot correlate them with any radio pulsars, X-ray sources or remnants of supernova flares. Figures 6; references 11: 6 Russian, 5 Western.

[143-11746]

GAS-DYNAMICS MODEL OF SOLAR WIND INTERACTION WITH IONOSPHERES OF COMETS

Moscow PIS'MA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 7, No 6, Jun 81
(manuscript received 17 Mar 81) pp 378-382

BARANOV, V. B. and LEBEDEV, M. G., Institute of Space Research, USSR Academy of Sciences, Moscow, and Moscow State University imeni M. V. Lomonosov

[Abstract] The authors use a method previously developed to design a model of the solar wind's interaction with the local interstellar medium to study the former's interaction with comet ionospheres. The authors use a gas-dynamics model of the two colliding flows' interaction based on the assumption that there are four characteristic areas to consider (undisturbed solar wind, solar wind compressed in the leading shock wave, an undisturbed flow of gas from the comet, and comet gas compressed in an internal shock wave). They then use gas-dynamics equations to make the necessary calculations. Although they are not fully satisfied with the model's correlation with observational data, they think it depicts correctly the basic features of the physical processes occurring when comet ions interact with the solar wind. Figures 4; references 14: 8 Russian, 6 Western.
[143-11746]

UDC 550.388.2

INDUCTION INTERACTION OF MOVING BODIES WITH IONOSPHERIC PLASMA

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 21, No 2, Mar-Apr 81
(manuscript received 18 Sep 80) pp 225-232

GUREVICH, A. V. and PASHCHENKO, N. T., Institute of Problems of Mechanics, USSR Academy of Sciences

[Abstract] A body moving through rarefied ionospheric plasma has electric currents induced on its surface, which leads to electromagnetic disturbances in the plasma. The authors' investigation centers on bodies moving at a speed greater than the speed of sound in the plasma but less than the Al'ven speed. They discuss the electric currents that arise on a body's surface, which are the source of the induction interaction, the induction interaction under the velocity conditions already stated, and special features of the induction interaction of bodies with the ionospheric plasma (the change in the structure of the disturbed zone, the appearance of magnetic perturbations, and the appearance of an additional resisting force). Figures 2, references 15: 3 Russian, 7 Western.
[146-11746]

DISTURBANCE OF SURROUNDING PLASMA'S PARAMETERS BY RADIO-FREQUENCY EMISSIONS FROM ON-BOARD TRANSMITTERS IN SPACECRAFT

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 21, No 2, Mar-Apr 81
(manuscript received 9 Jul 79) pp 239-244

CHERNOGOR, L. F., Khar'kov State University

[Abstract] In view of the ever increasing power of the transmitters used in spacecraft, the author investigates the possibility that their emissions might affect the parameters of the surrounding plasma, particularly the electron temperature and the frequency of ion collisions. He concludes that there is practically no disturbance of the electron temperature along a spacecraft's axis of motion, although there probably is some in the direction perpendicular to that axis (the direction in which the radio waves are assumed to travel). He reaches no conclusion about a change in the frequency of collisions. Figures 2; references 6: 2 Russian, 4 Western.

[146-11746]

UDC 550.388.2:521.61

DETERMINING ALTITUDE OF LAYER OF IONOSPHERIC HETEROGENEITIES ON BASIS OF RECEPTION OF TWO COHERENT FREQUENCIES FROM A SATELLITE

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 21, No 2, Mar-Apr 81
(manuscript received 25 Sep 79) pp 255-258

[Abstract] The authors discuss the possibility of using holographic methods to process satellite radio signals that have a statistical component in order to determine the values of variables that are the correlation function of the fluctuations in the refractive index and the altitude of the layer of heterogeneities in the ionosphere. Assuming a higher-frequency reference wave that does not interact with the layer and a lower-frequency subject wave that does, they derive an equation that enables both of them to be determined by finding the point of focus of one of its sides. References 4: 3 Russian, 1 Western.

[146-11746]

OPTICAL OBSERVATIONS OF LUMINESCENCE IN AREA OF THE ROCKET IN 'ZARNITSA-2' EXPERIMENT

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 21, No 2, Mar-Apr 81
(manuscript received 31 Jan 80) pp 309-314

IVCHENKO, V. N., MILINEVSKIY, G. P., MISHIN, Ye. V. and RUZHIN, Yu. Ya., Kiev State University and Institute of Terrestrial Magnetism, the Ionosphere and Radio Wave Propagation, USSR Academy of Sciences

[Abstract] The authors describe the "Zarnitsa-2" experiment, which involved the injection of an electron beam into the ionosphere. The pulses were 0.8 and 0.007 s long, separated by a pause of 0.8 s, and had electron current and energy levels of 0.27 A and 9 keV, respectively, in the first mode (93-129 s of flight time) and 0.45 A and 7 keV in the second (more than 130 s of flight time). They show that the basic features of the luminescence around a rocket can be explained by the collective interaction of the electron beam with the ionospheric plasma, the mechanism being the ignition of a beam-plasma discharge in the area of the rocket. Figures 4, references 18: 16 Russian, 2 Western.
[146-11746]

UDC 523.165

SPECTRUM OF COSMIC RAY ELECTRONS IN RANGE 7-40 MeV ACCORDING TO MEASUREMENTS ON 'PROGNOZ-4' SATELLITE

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 21, No 4, Jun-Aug 81
(manuscript received 26 Sep 80) pp 598-601

BASILOVA, R. N., LUPENKO, G. V. and PUGACHEVA, G. I., Institute of Nuclear Physics, Moscow State University

[Abstract] The "Prognoz-4" artificial earth satellite (launched 22 December 1975) carried an electron spectrometer for measuring the spectrum in the range 7-40 MeV. This spectrometer is described briefly, but has been fully described in other sources (R. N. Vasilova, et al., GEOMAGNETIZM I AERONOMIYA, Vol 17, No 1, 1977; L. F. Kalinkin, et al., GEOMAGNETIZM I AERONOMIYA, Vol 15, No 2, 1975). Most of the time the satellite was beyond the limits of the magnetosphere, in interplanetary space. Measurements of the background spectrum in the low-frequency range involved determination of the quiet level. The period selected was characterized by an absence of flares on the sun and in interplanetary space there were no high-velocity streams of plasma and shock waves. Accordingly, the entire measured flux can be attributed to the background flux of electrons during a quiet period. The authors describe the procedures for calibrating the spectrometer and the method for obtaining the spectrum. For example, the background level in different spectrometer channels was determined with the use of the results

of calibrations on a relativistic protons accelerator and using data from an analysis of nuclear interactions of cosmic rays at great altitudes in the atmosphere, measured using a photoemulsion. The resulting spectrum is compared with the results of measurements made by other authors. After analyzing the comparative results, the authors were able to suggest the requirements which an instrument intended for registry of low-energy relativistic electrons must satisfy. First, for suppressing the background the instrument must contain a detector making it possible to determine the direction of arrival of particles, second, the protective detectors must have a very high efficiency (about 99.9%), and third, the energy release detectors must have a good energy resolution (better than 30% and a possibility for determining the background level from nuclear interactions and reducing its value. Figures 2, tables 1; references 16: 7 Russian, 9 Western.
[162-5303]

UDC 550.388.2

STRUCTURE OF QUASIPERIODIC FLUCTUATIONS OF VLF HISSES

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 21, No 4, Jul-Aug 81
(manuscript received 5 Mar 80) pp 636-642

GORSHKOV, Yu. N. and DANILUSHKIN, A. I., Northeastern Multidiscipline Scientific Research Institute, Far Eastern Scientific Center, USSR Academy of Sciences

[Abstract] New data on the quasiperiodic modulation of VLF hisses obtained under surface conditions are given. In the processing of these data computations were made of the autocorrelation functions, static spectra of the envelope of the VLF signal, modulation intensity, relative amplitude of modulation and rate of increase of the VLF signal. An analysis revealed that there are some common regularities typical for wide-band quasiperiodic VLF hisses. These are illustrated in the example of a burst with a clearly expressed harmonic structure registered on 17 Mar 1977 at 1037 LT in the frequency band $f = 2.5-7.5$ Hz at Magadan station. The following picture was revealed. 1) Quasiperiodic fluctuations of VLF hisses are a result of several subharmonic oscillations with different periods which are superposed. 2) The period T of low-frequency modulation decreases with an increase in their relative amplitude I_{rel} . 3) The I_{rel} value, intensity of modulation m and modulation period T are related inversely proportional to the intensity of the unmodulated level of VLF hisses for low-frequency quasiperiodic modulation and by a quasi-harmonic dependence for the high-frequency quasiperiodic modulation. 4) The period, intensity and relative amplitude of modulation and the rate of increase of the VLF signal are dependent on time; the maximum values of these parameters are not established immediately, but after some cycles of oscillations. 5) The period of quasiperiodic modulation of VLF hisses is related to modulation intensity by a quasi-harmonic dependence. For low-frequency quasiperiodic modulation the period with an increase in modulation intensity on the average decreases and the process is attenuating. On the other hand, for high-frequency modulation the period with an increase in its intensity on the average

increases and the process is increasing or is not dependent on modulation intensity. 6) The parameters of quasiperiodic modulation (period, intensity, rate of increase, amplitude) are dependent on the frequency of the registered VLF signal, attaining a maximum within the investigated range. These experimental dependences are integrated, comparing them with some results of theoretical investigations of the conditions for the excitation of periodic regimes of oscillations in magnetically active plasma. The analysis revealed that the observed quasiperiodic modulation of VLF radiation can be explained by existing theories describing the conditions for the appearance of periodic regimes of oscillations in the magnetosphere. This affords new diagnostic possibilities of the surface VLF method in the investigation of ionospheric-magnetospheric plasma since the cited data show that on the basis of the parameters of quasiperiodic modulation of VLF radiation (period, amplitude, modulation intensity) it is possible to estimate the amplitude of the modulating hydromagnetic wave, electron concentration near the site of localization of the VLF source, increment of VLF waves, anisotropy, energy and pitch angles of resonance particles. Figures 6, tables 1; references 10: 9 Russian, 1 Western. [162-5303]

UDC 550.385.4

PLASMOSPHERIC NOISE RADIATION DURING GEOMAGNETIC STORMS

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 21, No 4, Jul-Aug 81
(manuscript received 25 Feb 80) pp 661-667

LARKINA, V. I. and LIKHTER, Ya. I., Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, USSR Academy of Sciences

[Abstract] A study was made of variation of plasmospheric noise radiations during geomagnetic storms of different intensity. The authors used the results of measurements of low-frequency radiations by the "Intercosmos-3" and "Intercosmos-5" satellites. These satellites, simultaneously with ELF and VLF wave radiations, also registered electrons $E_e > 40$ KeV. The data from these measurements were also used. A joint examination of the records of wave radiations and fluxes of leaking particles made it possible to detect characteristic relationships between these phenomena. This is illustrated in the example of events during the storm of 16-17 December 1971. It is shown that the interrelationship of electron fluxes and the amplitudes of low-frequency radiations detected in this storm is characteristic for all magnetic storms. The analysis of variations of the amplitude of plasmospheric radiations in the outer ionosphere during geomagnetic storms considered in this study and their comparison with similar variations of the intensity of fluxes of high-energy electrons leads to the following conclusions: 1) The region $L_{\max}$ where the amplitude of plasmospheric radiations is maximum (excitation region) during magnetic storms is always situated in the region of the gap between the radiation belts and the inner slope of the outer radiation belt. 2) The region $L_{\max}$ during storms moves simultaneously with the region $L'_{\max}$ where the flux of particles of the outer radiation belt is most intense, remaining somewhat (up to $0.5 R_E$) closer to the earth's surface. During the

strong magnetic storm in August 1970 the closest approach of $L_{\max}$ to the earth's surface, to $L = 2.5$, was registered. The rate of movement of $L_{\max}$ in the active phase of the storm was almost an order of magnitude greater than in the phase of storm recovery. The rate of movement of $L_{\max}$ is somewhat greater than the rate of movement of $L'_{\max}$ in the main phase and is equal to the rate of movement of $L_{\max}$ in the recovery phase. 3) As an average for many storms the amplitude of the low-frequency radiations (in db) varies proportionally to the D_{st} variation. Among the various indices of geomagnetic disturbance the D_{st} variation is most suitable for characterizing the intensity and position of the region of excitation of plasmospheric radiations. This is attributable to the fact that plasmospheric radiations are generated in the region where the equatorial current ring is situated and both the amplitude of the plasmospheric radiations and the intensity of the equatorial current are dependent on the stream of particles of the earth's radiation belt. The established typical characteristics of variations of plasmospheric noise radiations reflect the processes of restructuring of magnetospheric plasma during the time of geomagnetic storms: replenishment and losses of high-energy protons in the radiation belts, movement of the radiation belts (diffusion wave) and movement of the plasmopause. Figures 5, tables 2; references 20:

9 Russian, 11 Western.

[162-5303]

INTERPLANETARY SCIENCES

TASS REPORTS LAUNCHING OF 'VENERA-13'

Moscow PRAVDA in Russian 31 Oct 81 p 1

[Text] In accordance with the program for study of space and the planets of the solar system, the automatic interplanetary station "Venera-13" was launched in the Soviet Union on 30 October 1981.

The basic goal of the launch of the station is to continue scientific studies of the planet Venus. During the station's flight from Earth to Venus there are plans for studies of X-rays, gamma radiation, magnetic fields in space, characteristics of the solar wind, cosmic rays and the interplanetary plasma. Along with Soviet scientific apparatus the station carries instruments created by French and Austrian specialists.

The "Venera-13" station was placed in an interplanetary trajectory from an intermediate orbit as an artificial earth satellite. According to ballistic measurements the parameters of the flight trajectory are close to plan. The station should reach the vicinity of Venus in March 1982.

The on-board systems and scientific apparatus of the "Venera-13" station are working normally.

CSO: 1866/21-P

TASS ANNOUNCES LAUNCHING OF 'VENERA-14'

Moscow PRAVDA in Russian 5 Nov 81 p 1

[Text] In accordance with the program for study of space and the planets of the solar system, the automatic interplanetary station "Venera-14" was launched in the Soviet Union on 4 November 1981.

The "Venera-14" station is similar in design and mission to the "Venera-13" station which was launched on 30 October 1981. Parameters of the stations' trajectories are close to plan.

The flight of the two interplanetary stations will make it possible to obtain more complete data on the planet Venus as well as on physical processes taking place in space.

The on-board systems and apparatus of the automatic stations are operating normally.

"Venera-14", just as "Venera-13", will reach the planet in March 1982.

CSO: 1866/20-P

UDC 535.24:523.42

AEROSOL COMPONENT OF VENUS'S ATMOSPHERE, AS DETERMINED FROM RESULTS OF
SPECTROPHOTOMETRIC MEASUREMENTS MADE BY 'VENERA-11' AND 'VENERA-12' STATIONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jul 81
(manuscript received 12 Dec 80) pp 421-429

GOLOVIN, Yu. M., MOSHKIN, B. Ye. and EKONOMOV, APP.

[Abstract] The authors discuss the structure of the aerosol component of Venus's atmosphere at altitudes of 10-63 km (below which molecular scattering plays the decisive role in sunlight attenuation). The "Venera-11" and "Venera-12" used scanning photometers and spectrophotometers during their descent through the atmosphere in December 1978. The authors draw conclusions about the atmosphere's optical depth and coefficient of extinction and the cloud cover's optical thickness. The data supplied by these spacecraft did not differ substantially from that provided by American landers and the Pioneer Venus probes. Figures 11; references 15: 9 Russian, 6 Western.
[133-11746]

UDC 523.72:523.42

LOW-ENERGY ELECTRONS IN OPTICAL SHADOW OF VENUS DETECTED BY 'VENERA-9' AND
'VENERA-10' SATELLITES AS SOURCE OF NOCTURNAL IONOSPHERE: COMPARISON WITH
RESULTS OBTAINED BY PIONEER VENUS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 20 Aug 80) pp 430-435

GRINGAUZ, K. I., VERIGIN, M. I., BREUS, T. K. and IVANOVA, S. V.

[Abstract] Measurements made by a quadrupole mass spectrometer on Pioneer Venus show that at an altitude of about 140 km in Venus's atmosphere, the concentration of neutral particles is about $5 \cdot 10^9 \text{ cm}^{-3}$ and that the basic components are CO_2 and O_2 (about 60% and 30%, respectively). Based on data gathered by this satellite and the "Venera-9" and "Venera-10" probes, the authors calculate the altitudinal profile of the distribution of ionospheric ions, which was previously thought

to be higher, and conclude that it is too low to be a source of ionization of the nocturnal atmosphere. The primary source is probably impact ionization of the atmosphere by electrons. This is supported by measurements indicating that flows of ionizing electrons actually reach ionospheric levels. The probable source of these electrons' energy is the solar wind, the energy of which is somehow transmitted through electrons in Venus's plasma-magnetic tail that spill into the ionosphere. Figures 4; references 30: 16 Russian, 14 Western.
[133-11746]

UDC 551

PHOTOMETRIC STUDIES OF LUNAR SOIL ON BASIS OF DATA GATHERED BY 'LUNOKHOD-2'

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 5 Jun 80) pp 455-464

ZASETSKIY, V. V., LIPSKIY, Yu. N., deceased, and SHEVCHENKO, V. V.

[Abstract] Photometric investigations of lunar soil enable its reflective properties to be determined; in turn, this enables the soil to be categorized as "oceanic" or "continental." The "Lunokhod-2" carried a panoramic telephoto-meter with an external brightness standard. The authors discuss in detail the different albedos that were observed, as well as some of the features of the transitional "ocean-continent" zone. Figures 7; references 8: 5 Russian, 3 Western.
[133-11746]

UDC 521.6

METHOD FOR DETERMINING PARAMETERS OF ORBITS OF PLANETARY SATELLITES

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 15, No 3, Jul-Sep 81
(manuscript received 12 Feb 79) pp 153-158

CHUGUNOV, I. G., Astronomical Observatory imeni V. P. Engel'gardt

[Abstract] Most measurements of planetary satellite parameters are concerned with the distance between two satellites or a satellite and a planet, as well as the position angles corresponding to these distances. There is usually a time lapse between measurements of these parameters and a degree of arbitrariness in their use. The authors attempt to formulate a method that will eliminate it. Using the Saturn system as an example, they set up two systems of coordinates (Saturn's polar geocentric system of coordinates and a satellite's polar Saturnocentric system) and derive equations relating them to the two parameters mentioned above, as well as others. They derive a conditional equation that

makes it possible to utilize both micrometric and photographic observations to determine orbital parameters, as well as observations of satellite phenomena occurring in a planetary system. References 6: 6 Western.
[2-11746]

UDC 323.53

VELOCITIES OF METEORIC BODIES, ACCORDING TO RESULTS OF RADAR OBSERVATIONS:
II. OBSERVABILITY OF METEORS

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 15, No 3, Jul-Sep 81
(manuscript received 29 Jul 80) pp 174-178

VOLOSHCHUK, Yu. I., KASHCHEYEV, B. L. and TKACHUK, A. A., Khar'kov Institute of Radio Engineering

[Abstract] The authors discuss the question of the velocities of meteoric bodies near Earth's orbit. Because of the selectivity of observations, determination of the physical factor (the relative observability of meteors with different velocities and trajectory inclinations) entails considerable difficulties. An indirect method for determining it is suggested. Formulas are derived relating the apparent and true probability densities of several parameters and the following conclusions are reached: 1) in comparison with the apparent values, the true distributions of both the extra-atmospheric and heliocentric velocities of meteoric bodies are approximately identical; 2) the dispersion of the true distributions in the function $\lambda' - \lambda_a$ changes less than for the apparent ones, although the nature of the change remains the same; 3) the asymmetry and excess of the true distributions changes within wider limits than for the apparent ones; 4) the nature of the change of the excess factor of the true and apparent distributions as a function of $\lambda' - \lambda_a$ differs noticeably. Figures 4; references 9.
[2-11746]

UDC 528.94

DEVELOPING SERIES OF STANDARD MAPS FOR MAKING SMALL-SCALE THEMATIC MAPS OF PLANETS AND THEIR SATELLITES

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA in Russian No 2, Mar-Apr 81 (manuscript received 29 Oct 79) pp 60-68

DEPUTATOVA, V. N., assistant professor and candidate of technical sciences, SHINGAREVA, K. B., assistant professor and candidate of physical and mathematical sciences, and KUZ'MICHEVA, I. V., engineer, Moscow Order of Lenin Institute of Geodesy, Aerial Photography and Cartography Engineers

[Abstract] Presently available maps of the planets differ widely in terms of scale, projection, layout and degree of generalization and this often makes it difficult to compare and analyze the information presented. A description is

presented of an attempt to develop a series of standard maps for the purpose of creating thematic maps of planets of the earth and their satellites, with the intent of including these maps in a combined atlas. The varied subject matter of the maps for the atlas now being planned made it necessary to create standard maps in different projections, including Lambert equatorial equal-area zenithal projection, Postel equatorial equidistant zenithal projection and Mercator normal conformal cylindrical projection in combination with stereographic perspective projection. The characteristics of these projections are described and the reasons for their specific choice are given. The format of the atlas will be 27 X 35 cm and the standard maps will have the following scales: Phobos and Deimos--1 : 15,000,000, the moon--1 : 25,000,000, Mercury--1 : 35,000,000, Mars--1 : 50,000,000, Venus--1 : 75,000,000, and Earth--1 : 75,000,000. The grid spacing for meridians and parallels will equal 20° in order to ensure sufficiently precise coordinate referencing of objects of the terrain and to avoid overloading the chart. A system of conventional symbols has been developed which are divided into three groups: for representing 14 forms of relief to some extent characteristic of the celestial bodies treated, conventional symbols representing specific forms of relief, and out-of-scale conventional symbols which will make it possible to isolate certain distinctive features of planetary relief. The first group is subdivided into symbols representing young, clearly expressed forms of relief, and those representing older less pronounced forms. The second group includes symbols for forms characteristic only of a single celestial body, such as symbols for the volcanoes, labyrinth and boundaries of the polar caps of Mars, a symbol for Mercury's shelf and an area symbol for lunar plains of great length. The standard charts also include names for elements of the surface and the name of the chart, the scale and other information on the border of the maps. Only proper names of elements of the surface approved by the International Astronomical Union are indicated on the standard charts. A table of conventional symbols and copies of individual charts are presented. Figures 3; references 1 Western.

[158-8831]

UDC 523.4

THE GREAT RED SPOT AS SYNOPTIC VORTEX IN JUPITER'S ATMOSPHERE

Moscow PIS'MA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 7, No 8, Aug 81
(manuscript received 15 May 81) pp 505-509

SAGDEYEV, R. Z., SHAPIRO, V. D. and SHEVCHENKO, V. I., Institute of Space Research, USSR Academy of Sciences, Moscow

[Abstract] The authors attempt to construct an approximate analytical model that allows for the rotation imparted to Jupiter's Great Red Spot by the two adjacent currents that flow in opposite directions near it in the Jovian atmosphere. They begin with a two-dimensional system of equations that describes wave motions in a shallow, rotating atmosphere. After discussing several theories on the vortex nature of the Great Red Spot, they look for a solution in the

form of a single-connected vortex arising against a background of a smooth velocity profile in a shear current with a large shear. They conclude that their model is better than that of Maxworthy and Redekopp, since it does not assume the existence of vertical "walls" in the atmosphere and can be used for a quantitative as well as qualitative description of the phenomena observed. Figures 1; references 7: 4 Russian, 3 Western.
[1-11746]

UDC 523.947

JOINT SOVIET-FRENCH INVESTIGATIONS OF SOLAR CORONA: 3. STRUCTURE AND SOME DYNAMIC FEATURES OF SOLAR CORONA ON 30 JUNE 1973

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 58, No 4, Jul-Aug 81
(manuscript received 15 Feb 80) pp 810-824

VSEKHSVYATSKIY, S. K., DZYUBENKO, N. I., IVANCHUK, V. I., POPOV, O. S., RUBO, G. A., KUCHMIY, S., KUCHMIY, O. and SHTEL'MAKHER, G., Institute of Terrestrial Magnetism, the Ionosphere and Radio Wave Propagation, USSR Academy of Sciences

[Abstract] Using pictures obtained by the University of California's Los Alamos Laboratory during the eclipse of 30 June 1973, the authors discuss the general and detailed structure of the inner and outer corona up to 12 solar radii, identify "white" coronal details with X-ray and photospheric-chromospheric formations and magnetic neutral lines in the photosphere, and discuss features of the corona's dynamic activity in the neighborhoods of coronal holes. After listing the features discovered, by area, they present their conclusions in the following areas: the general characteristics of the corona on that date; the identification of coronal details, condensation and coronal intensification; arc systems, filaments, the longitudinal magnetic field and neutral layers; large wing-shaped rays and wings; the corona's fine structure; the outer corona's structure; coronal holes and the corona's dynamic activity. Figures 4; references 35: 11 Russian, 24 Western.
[3-11746]

UDC 521.13

NEW CLASS OF STATIONARY AND PROVISIONALLY PERIODIC SOLUTIONS IN THREE-DIMENSIONAL, RESTRICTED, ELLIPTICAL THREE-BODY PROBLEM

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 58, No 4, Jul-Aug 81
(manuscript received 1 Apr 80) pp 879-885

ZHURAVLEV, S. G. and GERASIMOV, I. A.

[Abstract] By expanding the perturbing function with the help of a computer, the authors find families of stationary and provisionally periodic solutions for the three-dimensional, restricted, elliptical three-body problem for

commensurabilities of the $2/1$, $5/2$ and $4/1$ types. They also find that the algorithm they propose makes it possible to find families of stationary solutions for any commensurabilities. After formulating the general problem, they discuss the two categories of solutions separately and conclude that the stationary solutions can be used to engender provisionally periodic solutions for individual types of commensurabilities. Figures 6; references 16: 6 Russian, 10 Western.

[3-11746]

LIFE SCIENCES

LEONOV ON COSMONAUT TRAINING

Moscow SOVIET MILITARY REVIEW in English No 6, Jun 81 pp 62-64

[Interview with Maj Gen Avn Aleksey Leonov by correspondent I. Barchukov: "Overcoming Weightlessness"]

[Text] [Question] Aleksey Arkhipovich, a few words about the so-called "ground" physical training of future cosmonauts.

[Answer] Cosmonauts must have excellent health and be well developed physically. Before being launched into space future cosmonauts take a course of training, including physical training. They also study methods of overcoming unfavourable factors, in particular the effects of short-term overloads, acceleration, weightlessness, and other phenomena and processes occurring during a space flight.

Physical culture and sport develop in the cosmonauts strength, agility, endurance, courage and the required coordination of movements. Exercises are carried out every day and take into account the individual peculiarities of each man. They are supervised by experienced trainers, instructors and physicians to exclude injuries and any deviations either in the rhythm of training or in the cosmonauts' health.

The Stellar Township has a good training camp which comprises a stadium, roofed halls and a swimming pool provided with special apparatus and simulators (loping and other types of swings, centrifuges, etc.) which reproduce g-loads, vibrations, rotations, weightlessness and so on.

The cosmonauts do physical exercises every day, in all weather and all times of the year. During the hours devoted to physical training they run, ski, swim and dive. Considerable time is devoted to vaulting over a trampoline net. They also practise rowing, cycling, acrobatics, gymnastics and exercises with weights. Mini-football, basket-ball and tennis are obligatory. All this improves the working rhythm of the heart, the lungs and the organism as a whole under a constantly increasing load. In short, cosmonauts' physical training must be extremely varied.

The cosmonauts like sports; they have sport ratings. They all meet the requirements of the Military Sports Complex and the "Ready for Labour and Defence" programme.

[Question] What other types of training do they have?

[Answer] The vestibular apparatus is trained by means of swivel chairs and a special Khilov plane-parallel swing. Cosmonauts intended for work outside the spaceship or station are trained for more prolonged stay in space in so-called "hydroweightlessness" swimming pools and then in a "flying laboratory" where they get acquainted with real weightlessness and practice work in open space.

Cosmonauts also need flight training. They constantly perfect their flying skill on transport planes and modern fighters.

They perform, according to a special programme, day and night jumps from different altitudes. Free fall during delayed jumps permits them to develop spatial orientation and coordination of motions in conditions close to those of weightlessness, cultivates in them the ability to act reasonably, quickly and logically in critical situations.

When a ship is launched into orbit the cosmonauts are subjected to considerable overloads and acceleration, during which they must retain the lucidity of mind and working capacity. The cosmonauts' physiological potentialities and qualities as operators at the active stage of launching into and recovery from orbit are determined on a centrifuge.

In normal conditions the human organism maintains a preset equilibrium and returns to it after accelerations and g-loads not in a chaotic way but according to a definite programme. Therefore experts are now studying the overloading conditions under which the human organism is removed from its normal state and are looking for ways and methods of ensuring maximum approximation of crews' operations at active stages of space flight to the normal level on Earth.

[Question] Aleksey Arkhipovich, we know that the spaceship commander is usually a military pilot. Will you explain why?

[Answer] There is hardly a profession now in which the sense of the new has been so inseparably combined with risk as in that of the cosmonaut. In each flight new situations arise, each crew member makes his first step in something, and this may involve risk.

The cosmonaut's reliability as commanders and operators must be very high. That is why they are so carefully selected from the strongest, most able and experienced fighter pilots.

Due to their flight practice military pilots already possess many of the skills required. Their organism is hardened, they can force themselves to work efficiently in dangerous situations at various physical and mental loads. They also know and understand in practice what risk means, can act courageously, resolutely and coolly in any situation, adopt sound decisions instantaneously at most critical moments, and find a way out of the most desperate situations.

We can say without doubt that cosmonauts' fearlessness in flights, cold-bloodedness in solving tasks and overcoming difficulties are forged on Earth during the training stage.

[Question] Do the crews of spaceships and stations get psychological training?

[Answer] So far no reliable method has been found for selecting men by compatibility of character. And to select such characters for space flights is especially difficult. Imagine being day in day out in the same conditions with possible equipment failure at any moment. But joint work and training, a tremendous desire to fly, to carry out investigations and enrich science with new facts help the cosmonauts to cope with their missions.

During joint training the cosmonauts get to know better each other's inclinations, capabilities and peculiarities, develop cooperation and the ability to understand one another at a word or glance. Group games, for instance, are an excellent means of cultivating collectivism and it is no mere chance that on sports grounds the space crew plays in the same team to develop mutual understanding. Hunting trips are also a good way of spending one's leisure and at the same time of training in endurance and practising certain "survival" elements.

The whole life of any man, and not only of a cosmonaut, his work and daily contacts with people, are nothing but psychological training. A man of any trade must in the first place be prepared to cope with an important and complicated job, not to lose his head, to render at any moment a helping hand to his comrade and fulfill his duty honestly to the end.

Every candidate cosmonaut is specially examined in a heat chamber where it is possible under the conditions of increased temperatures to reveal maximum mobilisation capabilities of the organism, to disclose and determine his reserve margin of strength.

All of them spend 10-15 days alone in a specially equipped surdochamber which helps determine cosmonauts' nervous and psychological resistance to a long stay in a limited space.

They are, of course, helped by experts, physicians, trainers and cosmonauts who have already been in space.

[Question] Aleksey Arkhipovich, now tell us, please, about physical training in space.

[Answer] The first cosmonauts, Yu. Gagarin and G. Titov, were given the following advice by physicians: "As few motions as possible. Do not turn your head," whereas P. Popovich and A. Nikolayev carried out twice a day a set of physical training exercises specially prepared for them.

At that time the number of exercises was limited. Then rubber and spring expanders appeared on board spaceships. A rubber absorber provided with strap loops is the most convenient and versatile gymnastics apparatus for cosmic conditions, making it possible to practise a lot of motions affecting almost all the muscle groups.

Nowadays crews in space perform a various sets of physical exercises, which are being constantly improved. On the Salyut-6 station there are several pressure suits. The cosmonauts were some of them 10-12 hours daily. They subject the

muscles to a certain stress corresponding to the load which is usual at any working posture on Earth. There are also a running track and a veloergometer. To provide comfortable conditions in the station for cosmonauts, use is made of a vacuum vessel (a vacuum Chibis suit) ensuring redistribution of the blood in the cardio-vascular system in conditions of weightlessness.

At present new methods are being introduced for supervising the cosmonauts' physical condition. Before and after flight they undergo a biomechanical examination which includes walking, jumping and physical exercises. Deviations revealed in the equilibrium system are registered and then used for further improving the training process. Experts advise the cosmonauts on the speed and ways of performing exercises, recommend this or that method of training.

During flights the cosmonauts are making more and more use of sport apparatus. Thus, L. Popov and V. Ryumin trained for about an hour a day on the veloergometer and almost for an hour and a half on the running track, practised strength-developing exercises with the expander. The training was based on a cyclic principle of proportional loads (three days training followed by a day's rest). Special attention was paid to developing strength and coordination habits by a special system of exercises for separate muscle groups. On the veloergometer the total load constituted 25-45 thousand kilogram-meters, and the total distance run on the running track was 3-5 kilometres.

Apart from the time of sleep the crew wore during the whole day Penguin suits producing stresses on the locomotor system. Once every ten days they underwent a thorough medical examination. All the data obtained testify that during the whole flight the cosmonauts were in good condition. They easily adapted to weightlessness and from the very first day experienced no difficulty in performing their flying mission.

For the first time, after the 185-day flight of L. Popov and V. Ryumin no reduction was observed in the strength of their shin posterior muscle group which on Earth helps maintain the vertical posture. This fact is accounted for by the adequate and correctly organised physical training in space flight. Indicators of the mechanisms of posture coordination, walking and other movements also improved.

During a long stay in space it becomes possible not only to study the reactions of the organism to weightlessness and to understand the mechanism giving rise to them, but also to learn to control the state of man to a certain degree during and after stay in this unusual medium.

The data obtained show that man can not only adapt to conditions of extended space flight, but can actively work in it. Quick readaptation after flight is evidence of intensive physical training on Earth and well thought-out exercises in flight.

No doubt in the not too distant future there will be stadiums in space and near-earth settlers will take part in cosmic expeditions just as on Earth. For the time being physical culture and sport remain an important component of complex preparation for any space flight.

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STATUS OF SPACE BIOMEDICAL PROGRAMS

Moscow PRAVDA in Russian 15 Jun 81 p 3

/Article by Avadalik Ignat'yevich Burnazyan, USSR deputy minister of health: "Man in Space"/

/Text/ An important stage in the conquest of space has been completed. Using "Salyut" ships and the "Soyuz-6" orbital station, over a period of 3 and 1/2 years there were five extended expeditions by Soviet cosmonauts and nine international crews that included representative of the fraternal nations that are participating in the "Intercosmos" program. The flights were preceded by extensive exchanges of experience and knowledge. It can be said with confidence that they contributed to the strengthening of the scientific and technical collaboration of the socialist countries.

Biomedical research was given a prominent place in the program. The scientific substantiation of methods for combatting the unfavorable effect of weightlessness on the body requires a thorough and clear understanding of the processes occurring during the course of the adaptation (acclimatization) of living systems to a world without weight. In this field, biological research during spaceflight is of considerable help to the medical specialists. Such research makes it possible to study the special features of adaptation on the tissue, cellular and molecular levels. In addition to this, the use in the experiments of a large number of animals makes it possible to obtain statistically reliable results.

Beginning in 1973, the USSR launched 4 specialized biological satellites in the "Cosmos" series. The research conducted with their help was of a complicated nature and was notable for the continuity and increasing complexity of the program. The basic goals of this research were to study the mechanisms of the effect of weightlessness on living systems, the combined effect of weightlessness and ionizing radiation, and the biological effects of artificial gravity.

Specialists from 20 scientific establishments in the Soviet Union and 32 in Bulgaria, Hungary, the GDR, Poland, Romania, Czechoslovakia, the United States and France took part in this research. The duties of the leading scientific establishment were carried out by the USSR Ministry of Health's Institute of Biomedical Problems. Working closely with biologists, engineers developed unique devices: a centrifuge for the creation of artificial gravity, an irradiator for measured irradiation from an artificial gamma-radiation source, instruments for growing and

fixing (preserving) plant organisms, thermostats, containers for various biological objects and other equipment.

The numerous experiments conducted on the "Cosmos" biological satellites and the "Salyut-6" station, using tissue and microbe cultures, did not reveal any harmful effect of weightlessness on cell and microbe cultures or intracellular processes, including those that are related to the transmission of hereditary information and control of the sequential fissioning of cells (the genetic apparatus). These data are of fundamental importance to cosmonautics, since they remove the basic biological limitation from the path of a gradual increase in the duration of manned flights into space.

Biochemical and morphological investigations of almost all the systems in animal organisms also did not reveal any pathological changes that were the result of the effect of weightlessness. At the same time, reversible structural-functional changes were observed in a number of organs and tissues (such as muscles and bones).

It has been established that the body's adaptation to weightlessness is governed by the same general biological laws that were established previously for the effect of other unusual environmental factors. As a result, it is possible to say with full substantiation that the biological research conducted on the "Cosmos" biological satellites and the "Salyut-6"- "Soyuz" complex, within the framework of the "Interkosmos" program, contributed to the improvement of the system for biomedical support of manned flights. At the same time, the causes of a number of changes that occur in man under the effect of weightlessness became clearer, along with ways of maintaining a high degree of fitness on the part of cosmonauts.

The international crews were given the assignment of studying the cardiovascular system during the so-called period of acute adaptation to weightlessness (the first 7 days of a flight). It is at this time that vestibular disruptions and disturbances in the blood circulation system that lower the fitness for work because of an increase in the flow of blood to the head and thorax are manifested particularly clearly.

The "Oxygen" physiological experiment was performed by a Soviet and Czechoslovak crew and utilized a portable "Oxymeter" instrument developed by specialists in the Czechoslovak SSR. In weightlessness there is a redistribution of blood in the blood vessels in the lungs, and this can affect the saturation of the blood (and, consequently, the body's tissues) with oxygen. The basic goal of the experiment was to determine whether or not the oxygen pressure level changes and to study the nature of its consumption by the body's tissues.

The experiment was later continued by international crews made up of representatives from the USSR and the Polish People's Republic and the USSR and the GDR. The investigations showed that during a flight there is a reduction in the oxygen content in the skin and a reduction in its utilization in comparison with both the preflight level for every cosmonaut and the average level for a large control group.

One of the promising instruments, which was used for individual monitoring of the degree of cardiovascular system pressure during functional load tests, was a Polish instrument with an audible indication of cardiac contractions. With its help, a Soviet-Polish crew monitored cardiac activity under loads. As a result of the

successful completion of the experiment, we have demonstrated the advisability of using the "Kardiolider-D01" instrument (or some modification of it) in combination with Soviet on-board prophylactic facilities--the veloergometer, the vacuum tank--in order to increase the effectiveness of their utilization during a flight.

The experiment named "Reo" made it possible to determine the special features of central and peripheral blood circulation and blood circulation in the brain when at rest, when negative pressure was applied to the lower half of the body, and when physical loads were applied. The ballistic cardiography method used during the Soviet-Romanian flight made it possible to judge the contractive function of the heart immediately, make an integral evaluation of the dynamics of the blood flow, and detect functional disruptions in the cardiovascular system. A densitography method that was proposed by Romanian specialists makes it possible to make a direct measurement of the duration of the cardiac cycle's phases when a physical load is applied. Interesting biomedical experiments were also prepared by specialists from Vietnam, Cuba and Mongolia.

A point of particular interest here is that because of their portability, reliability, simplicity of operation and the large amount of information they produce, at least six instruments created in accordance with the "Interkosmos" program will be used in practical medicine for diagnosing illnesses of the cardiovascular system, when evaluating fitness for work, and in clinical research.

Psychological research has recently been allocated an independent place in the series of joint experiments. This is understandable, since man's behavior and his working efficiency during the course of adaptation to new and difficult conditions depend largely on individual personality features.

Research done on the "Salyut-6"- "Soyuz" orbital complex under the auspices of the "Interkosmos" program helped us establish the fact that adaptation to weightlessness is coupled with readjustments in a cosmonaut's psychic activity: there are changes in reaction speed, information volume and processing speed and so on. The results that were obtained revealed the individual dynamics of the processes and functions that determine a man's mental fitness for work. The evaluation of such aspects of this fitness as decision-making, the selection of ways to achieve a goal and self-control was provided for in a special experiment performed by the Soviet-Romanian crew. During the course of this experiment there were tests for the subjective and objective evaluation of psychic tone, attention, self-control, visual-motor coordination and other indicators.

There is yet one more area where joint work was done: radiation safety during a flight into space. Here the basic attention was devoted to studying the radiation situation during manned flights in space stations and ships, substantiating safety norms for crews during flights of different durations, and developing means of protection against the unfavorable effects of radiation.

These investigations were carried out under spaceflight conditions and on the ground by specialists from the People's Republic of Bulgaria, the Hungarian People's Republic, the GDR, the Socialist Republic of Romania, the USSR and the Czechoslovak SSR. Dosimeters placed close to the cosmonauts' sleeping and working positions were used in the study. The accumulated doses of cosmic radiation were then measured on the ground. For this same purpose there was an on-board instrument panel

with thermoluminescent dosimeters, which was a "Pille" unit that had been created by Hungarian specialists. The results of the experiments inspire confidence in us that the problem of radiation safety on extended flights is being solved completely successfully.

However, it goes without saying that such a flight requires careful and--at the same time--operational medical monitoring. Therefore, the Center for the Collection and Processing of Medical Information has been established in the USSR. In the center there is automated, operational processing of the data that are of the greatest diagnostic interest, as well as hygienic and biophysical information. When evaluating a crew's state of health, in addition to the objective medical indicators great importance is attached to analyzing television images of cosmonauts and their radio conversations with the ground.

Using this center as a base, we have organized a consultative-prognostic group that examines all the medical information from a flight on a regular basis and prepares recommendations for the research program, prophylactic measures and correcting the operation of the life support system for the subsequent stages of a flight. In this case, also, the methods for evaluating the health of crew members, the programs for the machine processing of physiological indicators, and the methods for transmitting medical information over great distances are of great importance for practical public health services.

11746

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SUCCESSFUL TECHNIQUES FOR GROWING PLANTS IN SPACE

Riga NAUKA I TEKHNIKA in Russian No 8, Aug 81 pp 12-13

[Excerpts from article by Igor' Yudin, chairman, propaganda section, USSR Cosmonautics Federation: "Principal Purpose of Space Flights"]

[Excerpts] The flight of the "Salyut-6" station has continued for more than 3 1/2 years. Atmost 30 cosmonauts have made investigations aboard this station. The duration of work of the principal expeditions has increased: 96, 140, 175, 185 days.

During recent years, as a result of space investigations, specialists have obtained experimental data which in many ways have changed our concepts concerning the nature of the immediate and outlying neighborhood of our earth and adjacent celestial bodies. The application of the advances in cosmonautics in the national economy is broadening. At the same time information is accumulating on the extent to which man can successfully live and work in space. We will tell about some investigations in which the possibilities of "Salyut-6" station have been used.

K. Tsiolkovskiy, the founder of cosmonautics, wrote about space greenhouses. Aboard the ships created in his fantasy and directed to the planets of the solar system the crews were supplied with fresh vegetables and vitamins, plants absorbed carbon dioxide and generated oxygen, and the interior was suitably furnished. In other words, this was a "little piece" of that natural cycling of matter which exists on the earth. What is the present-day status of space greenhouses?

Experiments were no rarity on the orbital scientific complex "Salyut-6"- "Soyuz." The objective of biology is the development of bioengineering life support systems for prolonged and superprolonged space flights. Specially selected plants should reproduce the atmosphere and provide vegetable food. Such systems could also be used in industrial and agricultural complexes, bringing technological and food wastes into the cycle.

Why do we speak of bioengineering systems, not about purely biological systems? This is because the creation of a system similar to the earth's in the limited volume of an orbital station or interplanetary ship is an immeasurably complex problem. The rates of transformation of matter of different biological objects are different and as a result some of them will "enter a blind alley" and this will destroy the entire system. On the earth such a thing does not happen because the

cycling involves an enormous number of all kinds of substances and elements and the temporary dropping-out of some of them will not exert a substantial influence.

But on a spaceship it is possible to create an artificial system which includes both biological and physicochemical links. Their combination will make it possible to even out the metabolism slowing or accelerating natural processes.

In bioengineering systems the main role is played by plants -- both higher and lower. Many experts propose Chlorella, microscopic green algae, as a good supplier of oxygen. A liter of Chlorella suspension gives up to 50 liters of oxygen per day. Experimental systems for regenerating the atmosphere and water, based on the synthesizing capacity of unicellular algae, have already been created. Although Chlorella also contains proteins, fats, carbohydrates and vitamins necessary for nutrition, its processing involves great difficulties as a result of the strength of the cell walls. And man, to be sure, accustoms himself to such food only with difficulty. We are more accustomed to higher plants. In sending them into space scientists suspected that weightlessness would affect both the growth and development of these plants. The first experiments confirmed the worst fears. On the orbital station neither peas nor wheat produced either seeds or flowers: the plants died in the stage of their formation. The same fate befell other plants. At a definite stage in their development they seemingly encountered some biological barrier.

Why does this barrier come about? To what extent is weightlessness responsible for this? Do other spaceflight factors also not exert an influence here? A clarification of this is being sought by a number of scientific bodies in the country. In particular, it was decided to create the most favorable conditions for plants in space. Apparatus was developed ensuring the supplying of plants with nutrient solutions, light, and maintaining an optimum development regime.

L. Popov and V. Ryumin delivered to the "Salyut-6" station the decorative "Malakhit" greenhouse. Orchids specially selected by Ukrainian botanists were planted in this greenhouse. The orchids arrived in space in a flowering state. However, on the station the flowers almost immediately fell off. The experiment was repeated. The flowers again fell off.

Investigations were continued with another instrument -- the "Oazis." It included a unit for the cultivation of plants with three light sources, interchangeable growing pots with an ion exchange nutrient substrate, a pneumohydroapparatus for the supplying and measured application of water, systems for the telemetric monitoring of temperature and forced ventilation. Peas and wheat were cultivated. And again in the generative stage the plants ceased to grow.

In the "Svetoblok" instrument, consisting of a light source and chambers for the cultivation of plants on the nutrient medium agar-agar, V. Gorbatko and Pham Tuan carried aboard the station two-day-old sprouts of Arabidopsis -- plants with a short growing season which scientists commonly use in carrying out genetic experiments. In space Arabidopsis flowered, although no seeds were produced. Nevertheless, the flowering of a plant aboard a space vehicle is a highly promising development.

Specialists at the Smolensk Affiliate of the Agricultural Academy imeni K. A. Timiryazev and the Scientific Research Institute of Electrification of Agriculture selected another research direction. They used an electrical current for the in-space

stimulation of plant growth. This method has been known since the end of the last century. It is assumed that in plants electric stimulation increases the bioelectric polarity of tissues, favors the movement of ions and physiologically active substances in them, and also activates other processes important for the vital functioning of plants. Under terrestrial conditions several experiments were carried out in clinostats -- apparatus for simulating a state of weightlessness. Polyethylene beakers containing plants each two seconds were rotated with the roots first downward, then upward. During such a short period of time the course of biological processes could not be coordinated in the plants. Without electric stimulation they behave under these conditions as in space -- they extend out in all directions, turn yellow and wilt without producing either flowers or seeds. A different picture is observed during electric stimulation. The onion grows straight and its tips have a darker color. The pea flowers and has a fresh green color. Arabidopsis becomes almost twice as large as usual in height, flowers and gives fruits. The experiments are continuing. Specialists are seeking optimum variants of nutrient substrates and the best electric stimulation levels and regimes. At the Institute of Electrification of Agriculture more modern schemes and apparatus are being developed under the direction of Candidate of Technical Sciences U. Stetsyuk.

Scientists at the Botany Institute, Lithuanian Academy of Sciences, are cultivating sprouts in the small "Biogravistat" centrifuge. This will ensure acceleration of 1 g. The first experiments are encouraging.

The cosmonauts are assisting scientists in the solution of problems related to the creation of bioengineering life support systems. Interesting experiments with higher plants have been carried out by V. Kovalenok and V. Savinykh. Their objective was not only a clarification of the mechanisms exerting an influence on plant growth, but also a search for methods for reducing the negative influence exerted on them by spaceflight conditions. Evidently there will in fact be greenhouses in space.

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UDC 612.014

STATE OF JOINT RECEPTOR APPARATUS OF TURTLES UNDER SPACEFLIGHT CONDITIONS ON
'COSMOS-690' AND 'COSMOS-782' BIOLOGICAL SATELLITES AND 'SOYUZ-20' SPACECRAFT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19 No 3, May-Jun 81
(manuscript received 13 Mar 80) pp 490-492

DROBYSHEV, V. I. and MAKAROV, V. V.

[Abstract] In order to obtain basic information on the effects of spaceflight factors on the state of the joint receptor apparatus, a study was made of the shoulder, elbow, pelvis and knee joints of turtles during the flights of the three spacecraft mentioned in the title. A total of 206 joints from 40 turtles were studied. After a 19.5-day flight in the "Cosmos-782," an increase (in comparison with a control group) in the number of joint receptors with reactive changes was observed. Such changes were even more pronounced after an extended flight on the "Soyuz-20." Doses of ionizing radiation on the 10th day of the 20-day flight of the "Cosmos-690" also caused an intensification of these changes. Figures 2; references 9: 8 Russian, 1 Western.
[133-11746]

UDC 575.24:595.773.4

EFFECT OF DYNAMIC FACTORS OF SPACEFLIGHT ON THE MUTAGENIC EFFECT OF RADIATION:
REPORT 2. APPEARANCE OF RECESSIVE LETHALS AND X-CHROMOSOME LOSSES IN DROSOPHILA
MELANOGASTER OOCYTES

Moscow GENETIKA in Russian No 3, Mar 81 (manuscript received 11 Dec 79) pp 455-459

KOGAN, I. G. and GROZDOVA, T. Ya., Institute of General Genetics, USSR Academy
of Sciences

[Abstract] The authors use experimental data to test the hypothesis that if the modifying effect of the dynamic factors of spaceflight is related to an increase in the single-impact component of radiation damage, it can be detected by calculating the frequency of appearance of chromosome losses and recessive lethal mutations. They list the details of their experimental procedure. They

find that the dynamic factors have no modifying effect on the frequency of chromosome losses in irradiated *Drosophila* oocytes, although there is an increase in the number of dominant and recessive lethals, which leads them to assume that the dynamic factors reduce the probability of reparation of radiation damages before the formation of chromosome breaks. The authors used acceleration and vibration loads closer to those actually encountered in spaceflight than were used in previous experiments. They conclude that the data they obtained confirm the possibility that the damaging effect of radiation is intensified by the dynamic factors of spaceflight. Figures 2, references 16: 5 Russian, 11 Western. [129-11746]

SPACE ENGINEERING

INSTITUTE DIRECTOR DISCUSSES KRT-10 AND OTHER SPACE ANTENNAS

Moscow STROITEL'NAYA GAZETA in Russian 12 Apr 81 p 3

[Article by I. Zagura covering a discussion with Nikolay Prokof'yevich Mel'nikov, member of the USSR Academy of Sciences and director of the Central Scientific Research and Design Institute for Steel Construction of the USSR Ministry of Construction: "Window to the Universe"]

[Text] Twenty years ago on that memorable April day, the first orbit of "Vostok" with Yu. A. Gagarin aboard opened to mankind not only the space outside the earth. It also opened the working space of the cosmos and the most gigantic construction site on which the first, but very serious steps are now being taken.

From Novyye Cheremushki in Moscow to Orbit

The 10-meter umbrella of a radiotelescope antenna was spread in the center of the testing hall. Three collapsible supports were already unfolded. They are 3-sided, 5-meter long girders. A special container is suspended over the still folded antenna mirror. Radiators, four megaphones for the 12-centimeter band and a spiral for the 72-centimeter band are attached to its body. High frequency radiation meter amplifiers and a heat regulation system are located in the hermetically sealed compartment of the container.

And finally, without haste the antenna mirror was slowly opened wide. It has a reflective surface made from a specially knitted grid bed, woven from 50-micrometer thick metallic fibers. Wires with small weights held the construction suspended from the ceiling. This is a system for compensating for the weight of its elements. In this way weightlessness was simulated. After a while the "KRT-10" radiotelescope will also precisely deploy its mirror in near-earth orbit.

"It is well known how the 'KRT-10' functioned in orbit," said N. P. Mel'nikov, a member of the USSR Academy of Sciences and director of the Central Scientific Research and Design Institute for Steel Construction of the USSR Gosstroy.

"But there are probably few who know that the development of the construction was begun almost five years after Yu. A. Gagarin's flight. And even then to some, this project seemed like something in fantasy land. In reality, the building of the 'KRT' turned out to be an extremely difficult and complex problem. The most various of tasks were combined in it - the necessity of creating an

unprecedentedly light and at the same time, strong construction. Not to mention the fact that a large size device had to be unfolded from very compact units in space. And there is hardly any need to mention that it was demanded in these very same conditions to 'inscribe' a radiometric circuit with good characteristics and it was imperative to do this in miniature and with minimal energy requirements."

"But, Nikolay Prokof'yevich, after all, your institute, which recently marked a century of existence, has accumulated great experience in the conduct of research work and complex engineering calculations."

"It should be taken into consideration that many structures were built for the earth. And this is space, weightlessness. I can say that in the initial version we tried to design a 1,000-meter antenna. I think we will work on this again. As they say, in good time or somewhat later. But naturally, in the development of the first space radiotelescope in the world a great role was played by the experience in the building of original ground metallic structures. Our specialists took the most direct participation in the design of the 'Orbita' stations and a number of objects at the Long-Range Space Communications Center."

"Soyuz-34" - "Salyut-6" - "Progress-7"

On July 18, 1979 "Progress-7" moved away from the orbital station and after it the "KRT-10" was advanced and opened. The opening process was observed by television devices of the cargo ship.

The antenna came out in the precise design position.

"The onboard astrophysical studies," N. P. Mel'nikov says, "were conducted for the development of radioastronomical methods in space. They were conducted in two modes: circular rotation of the craft around a transverse axis for mapping of the Milky Way and constant orientation of the craft for observation of a pulsar, together with a 70-meter radiotelescope in the Crimea. A fundamentally new result was achieved in the geophysical studies, the highest resolution in measurements from space of the radio temperature brightness of the earth and the world's oceans. It is interesting that on one of the orbits of the 'KRT-10' the radiation from the volcano Etna, which was active at that time, was recorded. But the antenna intercepted the radio burst of the volcano at a distance of only several hundred kilometers. But when the 'KRT-10' was set into motion, evaluations were immediately conducted of the actual resolution of the antenna and data were taken on the quality of its opening. Such an operation was conducted from measurements of the radio radiation of an object from the earth, the sun and from the discrete source, Cassiopeia-A. Just imagine how different in strength and nature the signals were which the 'KRT' antenna had to precisely receive."

Signal reception capability depends on the 'mirror' surface. Imagine that the thickness of a sheet of newspaper is the distance from the earth to the sun (150 million kilometers or eight light minutes). Then the length to the nearest star will look like a pile of newspaper sheets approximately 21.5 meters thick. The diameter of our galaxy (100,000 light years) is a 'skyscraper' of newspapers 500 meters tall. But the boundary of the region of space known to us will not

be reached until the stack of sheets rises to a height of 49 million kilometers, which is a third of the way from the earth to the sun. Radio signals which must be received and isolated by the antenna burst through such distances to us. It is worth noting that in operation with a ground telescope, the effective area of the 'KRT-10' antenna grew to 1,000 square meters. It is easy to imagine what possibilities are being opened up today to the science about the universe."

Earth - Space, in the 2001

The structures of the Baykonur launch complex are familiar because of the many photographs and television shows. The antennas of the ground radiotelescopes receive data from the near-earth orbits of space ships and signals from the depths of space.

The specialists of the Central Scientific Research and Design Institute for Steel Construction had a share of the labor in their development and construction.

"But, Nikolay Prokof'evich, what is next, let us say, in the next 20 years?"

"Why so far in the future? The intensity of space research is growing not by days, but by the hour. Our institute, as you see, is already working not only at supporting operations in space, but directly with these operations. Today we have three directions which are being precisely followed: structures of a traditional nature, fully rotating ground antennas and space antennas. But today, even in the traditional structures, one can notice features of the space age. Our specialists have developed many designs for various towers and masts which stand in many regions of the country. And just now a design is being completed for a unique, 1-kilometer high mast. A 4-kilometer one is on the horizon. The structure is the most complex. It is probably sufficient to say that it will require approximately 350,000 tons of steel, while only 25,000 tons more went to the construction of the first phase of the Kama Motor Vehicle Factory."

"It is natural to ask: why are such masts necessary? They will find many uses. For example, the state of the atmosphere can be completely observed at such altitudes from such towers."

"It is true, for now these are more or less exotic subjects. But the antennas of large ground radiotelescopes with a diameter of approximately 100 meters, whose construction we have started, are real objects. The most powerful of them has rotating structures which alone weigh 12,000 tons. And first of all, they must be protected from all external effects, such as corrosion, wind, vibration and other effects. The antenna must preserve a given form in all conditions. For instance, with a mirror diameter of 64 meters, its parabola can be bent no more than 0.5 millimeters. Today communications are being shifted to higher frequencies which requires even greater precision of structural calculations and their reliability."

The specialists of the institute proposed an original solution. A specific maximum of deformation is assigned in the construction itself. And when it changes, then the focus of the mirror changes. It is probable that the assigned law of deformation found may be used not only in star tracking."

"And new space telescopes are on the horizon. Today the institute's specialists are working on the design of folding antennas with diameters of 30 and 100 meters. The same principle as with the 'KRT-10' will be embodied in them. The principle has completely justified itself. And even further, there will be telescopes on the planets and on our moon. And, I believe the time is not far away when automatic telescopes will be followed by even larger objects, assembled in orbit around the earth and in deep space. It is very near."

9767

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GAMMA-RAY INSTRUMENTATION AND ITS USES IN SPACE

Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 81 pp 4-8

[Article by V. G. Kirillov-Ugryumov, doctor of physics and mathematical sciences, R. Z. Sagdeyev, academician, and Yu. P. Semenov, doctor of technical sciences: "Prospects for Observational Gamma-Ray Astronomy"]

[Text] The Soviet Union and the United States are conducting studies using complex space observatories. These studies will enable us to examine astrophysical objects in various ranges of the electromagnetic spectrum.

Particular Features of Gamma-Ray Telescopes

Progress in any area of observational astronomy is determined by achievements in technological experimentation and by the introduction of more sophisticated instruments. In every instance, astronomy's assimilation of a new band of electromagnetic radiation has been accompanied by the discovery of fundamental astrophysical phenomena. Proof of this can be seen in the impressive data obtained through x-ray astronomy, an area that has already become well established (ZEMLYA I VSELENNAYA, 1981, No 2, pp 28-33--ed). With respect to volume, quality and significance of information obtained, this branch of astronomy has been compared with the classical spheres--with optical and radio astronomy, for example. Assimilation of the gamma-radiation sphere was delayed for reasons completely different from the proposition that this area might be less important or informative. The delay is related to technique and procedural difficulties which can be explained in the particulars related to detection of gamma-ray quanta in space.

In the first place, the absolute flow of gamma-ray quanta from astrophysical objects is quite small. Gamma-ray telescopes register quanta literally by the piece. For example, gamma-ray quanta having an energy greater than 100 MeV from a single bright source of gamma rays--the pulsar PSR 0531+21 in the Crab Nebula--fall upon the functional area of the satellite telescope COS-B (24x24 cm² in area) with a frequency of only six quanta per hour! This compels us to increase the area of the telescopes as well as the observation duration.

Secondly, there are tremendous background flows which interfere with the measurements (ZEMLYA I VSELENNAYA, 1981, No 3, pp 24-27--ed). Intensity of the charged component of rays found in space exceeds the flow of primary gamma-ray quanta by a

factor of 10,000. Energetic protons, electrons and nuclei can not only imitate quantum registration in the gamma-ray telescope, but, as a result of interactions, they cause a glowing of the substance that surrounds the detector in that band of the electromagnetic spectrum which is under study. In addition, the gamma-ray glow of the earth's atmosphere exceeds the flow of gamma-ray quanta emanating from astrophysical objects under study by several orders of magnitude, and compels us to outfit our gamma-ray telescopes with special instrumentation that will enable recording of the gamma-ray quanta of interest.

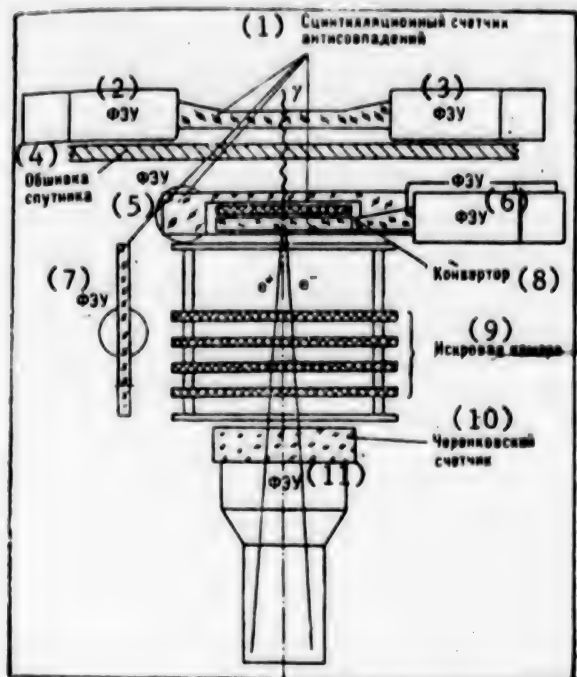
Finally, we turn to the third feature typical of extra-terrestrial astronomy with regard to any device--limitations in mass, dimensions and electrical power capacity of the instrumentation, and more rigid requirements with regard to strength, reliability and stability of the equipment's parameters over the course of extended periods of time. Space telescopes are therefore significantly different from similar units used to register elementary particles and nuclei on the earth. Nonetheless, the physics concepts in building satellite-based gamma-ray telescopes are the same as those for ground-based units.

Space-oriented gamma-ray telescopes must be able to "see" the difference between photons of cosmic origin and charged particles and photons from the earth's atmosphere--also to determine their direction of arrival and energy level.

Methods of conducting research related to gamma-ray quanta in the range up to 10 MeV are significantly different from those that deal with the range over 10 MeV (ZEMLYA I VSELENNAYA, 1981, No 3, pp 16-20--ed).

In order to isolate from their background and determine direction of arrival for gamma-ray quanta with energy greater than 30 MeV, spark chambers that exhibit a different form of obtaining information are used in the telescopes already built on the COS-B and SAS-2, and in the modern telescopes that are being designed.

The first satellite-based gamma-ray telescope with spark chamber, in which events were recorded on photographic film, was developed at the Moscow Engineering and Physics Institute and mounted on the artificial earth satellite "Cosmos-264" in 1969 (ZEMLYA I VSELENNAYA, 1973, No 1, pp 6-11--ed). Gamma-ray quanta in the converter are transformed into a pair of charged particles--an electron and a positron--whose ionized traces are recorded by the spark chambers. The direction of the gamma-ray quantum itself is re-created by these traces. The spark chamber technique enables us to increase the effective area and the aperture of the telescope without any degradation in the device's resolution capacity. Analysis of the particle traces in the chamber allows us to exclude spurious events from consideration and reduce the background. Scintillation counters are used to prevent the gamma-ray telescope from being turned on due to charged particles. They surround the spark chambers and are included in an anticoincidence circuit (ZEMLYA I VSELENNAYA, 1981, No 3, pp 16-20--ed). A Cerenkov counter is usually positioned under the spark chamber. Its function is to allow an event to be recorded only when a charged particle passes from top to bottom with greater-than-threshold velocity. This basically eliminates the background flow of gamma-ray quanta from the earth's atmosphere.



Key:

1. Scintillation anticoincidence counter
2. Photomultiplier
3. Photomultiplier
4. Satellite casing
5. Photomultiplier
6. Photomultiplier
7. Photomultiplier
8. Converter
9. Spark chamber
10. Cerenkov counter
11. Photomultiplier

Diagram of the gamma-ray telescope in operation on board the artificial earth satellite "Cosmos-264"

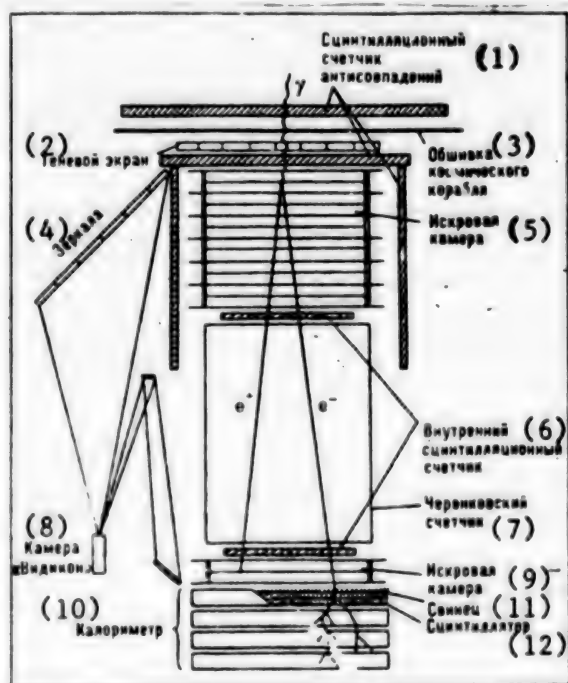
Studies conducted on the SAS-2, COS-B and other satellites and high-altitude balloons in the 30-2000 MeV range have yielded a number of important results related to diffusion galaxy gamma radiation (ZEMLYA I VSELENNAYA, 1981, No 3, pp 24-27--ed) and to discrete sources (ZEMLYA I VSELENNAYA, 1981, No 3, pp 21-23--ed). Nonetheless, the insufficient angular resolution the telescopes possess has left unanswered an important question. What is it that provides the basic contribution to the diffusion radiation under study--the interstellar medium or non-resolved, discrete sources? For this reason it is impossible, as a rule, to identify gamma-ray sources with objects under observation in other bands of the electromagnetic spectrum. The question of duration of discrete gamma radiation sources is of fundamental importance. If, for example, a source in the ρ region of Ophiuchus is related to the interaction between cosmic rays and a dense cloud of gas and dust, its angular dimensions will be about 0.2 degrees (and this is beyond the capabilities of existing gamma-ray telescopes).

The Orbital Space Observatory

It is advisable to conduct the next step in the study of astrophysical objects--especially those such as active galaxies and bursting stars--in a comprehensive manner along with simultaneous recording of emanations from these objects in various bands of the electromagnetic spectrum. The orbital space observatory (OSO) can be mounted on a spacecraft capable of lifting scientific equipment with mass on the order of two tons into an orbit 300 to 400 km in altitude, of effecting three-axis reference orientation to accuracy of at least 0.5 degree, and of conducting observations over an extended period of time.

The following can be included in the OSO: a large gamma-ray telescope encompassing the energy band from 50 MeV to 5 GeV, a soft gamma-ray telescope with energy from 40 keV to 5 MeV, and an x-ray spectrometer linked to a micro-computer that operates in the range 3-25 keV.

A telescope for recording hard gamma-ray emanations should serve as the basis of the observatory. In contrast to the telescopes mounted on the SAS-2 and COS-B satellites, it is advisable to use a wide-gap spark chamber in this telescope. In the compartments of such a spark chamber, the spark follows along the particle trace if its trajectory does not deviate from the vertical by more than 20 degrees. In this variant, the spatial accuracy of coordinate determination undergoes less improvement than that of spurious spark-overs which distort the picture. An optimal number of spark intervals was found for the specified dimensions of the chamber, and a thickness was determined for the electrodes providing for the best precision in measurement of the direction and energy of gamma-ray quanta while maintaining a sufficiently high recording efficiency. Twelve spark intervals are separated in turn by electrodes--convertors made of copper and aluminum with thicknesses of 0.14 and 4 mm, respectively. The efficiency of recording gamma-ray quanta with energy of 100 MeV is about 20 percent. The area of the telescope's plates is 50x50 cm², four times greater than for COS-B. Results of calibration measurements in spark chambers of the "Daisy" accelerator in Hamburg and the "Pakhra" in Troitskiy have shown that their angular resolution is twice as good as that of the COS-B.



Key:

1. Scintillation anticoincidence counter
2. Shade screen
3. Spacecraft casing
4. Mirrors
5. Spark chamber
6. Internal scintillation counter
7. Cerenkov counter
8. "Vidicon" chamber
9. Spark chamber
10. Calorimeter
11. Lead
12. Scintillator

Diagram of a large gamma-ray telescope

The telescope should provide for the extraction of information from the spark chambers using a vidicon. This mode can be duplicated by a photographic one for precision measurements of individual celestial sectors. We will recall that the vidicon is a transmitting picture tube with an electrical-conducting target. Under excitation by light from the transmission object, a distribution of charges is formed on the target corresponding to an image of the object. The charge from the target is read out as an electron beam, controlled by magnetic and electrostatic fields. Direction of movement of the gamma-ray quanta with energy greater than 1 GeV can be determined to an accuracy of one degree. Further refinement of the telescope's angular resolution is possible when a shade-screen device is positioned in the aperture. As tests have shown, for energy greater than 100 MeV this method permits attainment of angular precision up to 0.25 degree (ZEMLYA I VSELENNAYA, 1981, No 3, pp 21-23--ed).

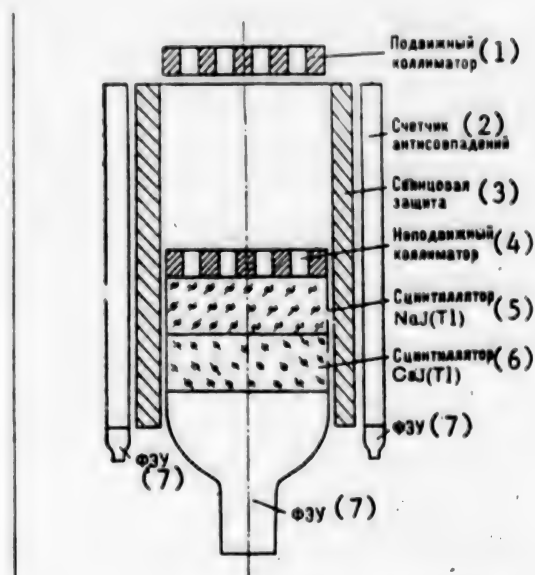
Two internal scintillation counters and a gas Cerenkov counter are used for recording gamma-ray quantum events. Each scintillation counter consists of four independent counters with dimensions 40×10 cm² and thickness of 1-2 cm, in which the events of one or two particles passing through may be isolated. If the particles do not pass from top to bottom, but just the opposite, then the particular event is not recorded. The gas Cerenkov counter isolates events corresponding to the passage of gamma-ray quanta for apertures of up to 10 degrees. The Cerenkov counter is filled with freon to a pressure of four atmospheres, and cuts on only when the speed of the particles travelling top-to-bottom exceeds 0.9984 the speed of light. The effective area of the counter is 1250 cm². The minimum energy of particles that will cause turn-on of the counter is 7 MeV for electrons and 12 GeV for protons.

Anticoincidence counters do not record charged particles which pass through the telescope. Insofar as the telescope must be positioned inside the orbital observatory, background flows of gamma-ray quanta may be formed by the charged particles of cosmic rays within the confines of the spacecraft. The spark chamber aperture must therefore be spanned not only by a counter directly over the chamber, but also by a counter mounted on the external face of the observatory. Particle traces in the spark chamber are recorded by the vidicon and photographed through lateral anticoincidence counters.

The energy of gamma-ray quanta can be measured either by electron dispersion on the plates of the spark chamber or by an ionized calorimeter positioned at the lower portion of the apparatus. The calorimeter should consist of intermittent layers of lead and scintillators 18.5 cm in overall thickness. Its dimensions are 60×60 cm², its mass--300kg. The calorimeter must be divided into four sections, each of which is surveyed by photomultipliers. The mean error for measuring energy of 100 MeV amounts to about 40 percent. The total amount of telemetric information from the telescope can reach up to 60 megabits per 24-hour period.

The minimal flow from a discrete source that will be recorded is, to a significant degree, related to the background intensity. The possible background for a spacecraft's design and construction was evaluated with the aid of the "Yelena-F" small-scale telescope on board the space complex "Salyut-6" - "Soyuz" - "Progress" (ZEMLYA I VSELENNAYA, 1980, No 1, pp 30-33--ed). The background intensity did not exceed 10^{-3} photons per cm²sec steradian for gamma-ray quanta with energy greater than 100 MeV.

The basis of the gamma-ray telescope for soft gamma radiation is the scintillation counter with NaI(Tl) crystal 200 cm² in area. The use of mobile and non-mobile collimators will permit improvement of the device's angular resolution to 0.5 degree, and will eliminate the effect of the non-stationary background, which is especially significant during low-orbit operation.



Key:

1. Mobile collimator
2. Anticoincidence counter
3. Lead shield
4. Non-mobile collimator
5. Scintillator, NaI(Tl)
6. Scintillator, CsI(Tl)
7. Photomultiplier

Diagram of a gamma-ray telescope for soft gamma radiation. The scintillator CsI(Tl) is intended for suppression of gamma-ray quanta that enter from the earth's atmosphere.

In 1977 an analogue of the telescope was launched on the satellite "Meteor." In the energy interval from 25 to 50 keV a flow of quanta from the Crab Nebula was recorded that had an intensity of $7.8 \pm 1.3 \cdot 10^{-3}$ photons per cm²sec·keV. These figures coincide with the results of measurements accomplished through other means.

In order to observe the same objects in the x-ray band, a four-energy band spectrometer can be mounted on the space observatory in the 3-25 keV region. Synchronous measurements on all telescopes will permit measurement of the periods of double systems and pulsars, discovery of how energy spectra change in time, and, in particular, the ascertaining of paths of iron atoms with an energy of 6.7 keV. To expand the range of time measurements, the spectrometer is combined with a special computer. This provides for partial processing of the information and its packaging for transmission to earth.

With the aid of four independent, proportional counters, an x-ray spectrometer will permit study of a source's x-ray variables and their localization in a device with 10 degree x 10 degree field of view, with an accuracy of up to 0.5 degree. Estimates indicate that the spectrometer will be able to record sources of periodic x-ray emanation of intensity 500 times less than that of the Crab Nebula.

The program of measurements on board the OSC should envisage both the combined, synchronous operation of all telescopes and the autonomous operation of each of them.

Measurement devices of the observatory must undergo advance testing and calibration. The anticoincidence system efficiency of gamma-ray telescopes will be checked on proton accelerators. Electron accelerators will be used to measure telescope characteristics throughout all the energy bands of gamma-ray quanta for various angles of incidence.

The duration of the observatory's operation in orbit should not be less than one year. The average exposure time for a celestial sector is about two months, of which approximately one-third is devoted purely to measurements. The earth blocks these objects the rest of the time.

The first portion of the observation program should include research with respect to the well-known sources of all wavelengths, pulsars PSR 0532 or PSR 0833. Without a doubt, it is essential to conduct careful research on the center of the galaxy. The anti-center of the galaxy evokes particular interest--here are located two bright, periodic gamma-ray sources, one of which--the CG 195+1 with period of 59 seconds--is at present not identified with any object in another energy band. Then there are other areas--the constellation Cygnus, the active galaxies NGC 4151, 3C 120, the quasar 3C 273, the gas-dust complexes of ρ Ophiuchus and λ Orion, among others.

Data on gamma radiation obtained up to the present time relates to energies greater than 40 MeV. The sphere of cosmic gamma rays from 10 to 50 MeV in energy remains the area of least knowledge, and this is an important area for determining the relationship of streams of protons and electrons in cosmic rays. The fact is that radiant emittance of the interstellar medium in the 20-50 MeV range is determined by interaction with interstellar gas, basically of the electron component of cosmic rays; for energy greater than 70 MeV--of the proton component. Apparently, the relationship between corresponding flows of gamma-ray quanta characterizes the composition of cosmic rays in various regions of the galaxy.

A telescope is currently being developed for recording gamma-ray quanta in the 10 to 100 MeV energy region. The working area of the telescope is 576 cm², and the energy resolution is about 30 percent for energy of 40 MeV. The first model of the telescope underwent successful testing during studies of gamma-ray quanta flow in the upper layers of the atmosphere following the launch of balloons in the USSR and India.

Research in the field of gamma-ray astronomy is being conducted in the Soviet Union by scientists at the Institute for Space Research of the USSR Academy of Sciences, at the Institute of Physics Engineering of the USSR Academy of Sciences, the Physics Institute of the USSR Academy of Sciences, at the Moscow Physics Engineering Institute and in collaboration with French laboratories in Toulouse and Sakle.

The American Space Observatory

The basis of the American program of gamma-ray astronomy observations is the Gamma Ray Observatory (GRO), whose launch is programmed for 1985-1986 with the aid of the "Space Shuttle" transport ship. A platform with overall mass of about 25 tons will

be injected into an orbit 400 km in altitude. Guidance and retention accuracy of the platform is about one degree. Positioning of the telescope's axes in space will be determined with a precision of up to two minutes.

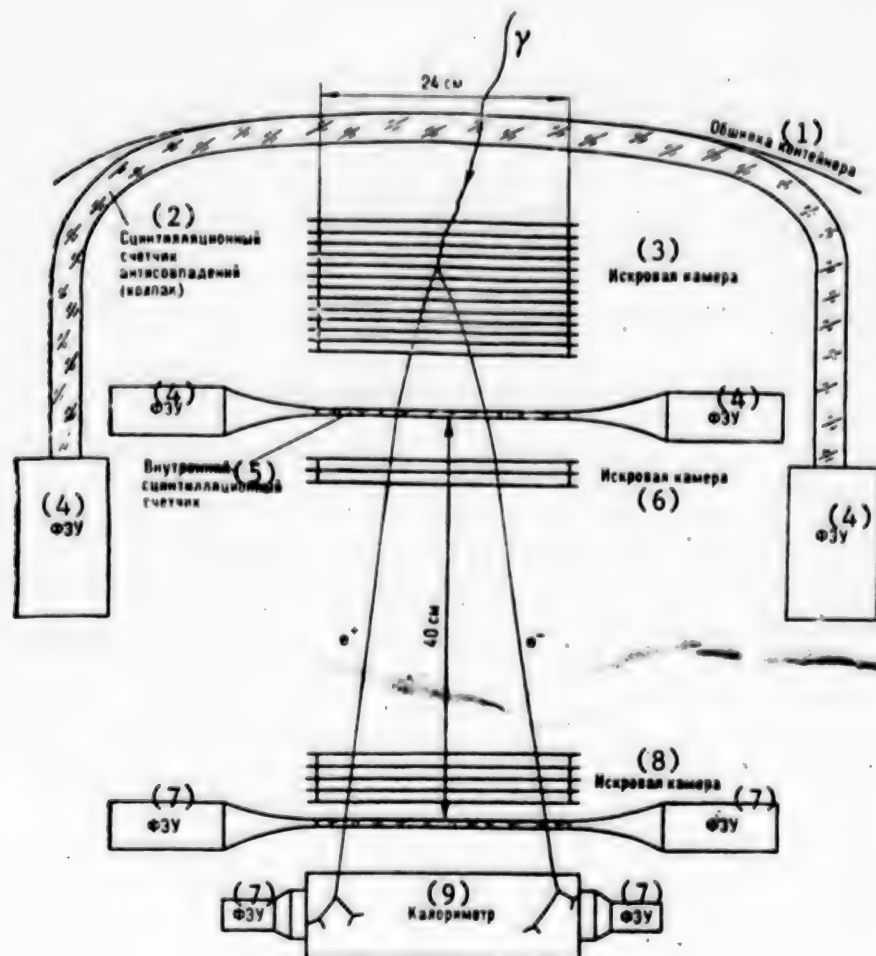


Diagram of a medium-energy telescope

Key:

1. Container casing
2. Scintillation anticoincidence counter (dome)
3. Spark chamber
4. Photomultiplier
5. Internal scintillation counter
6. Spark chamber
7. Photomultiplier
8. Spark chamber
9. Calorimeter

The following are components of the GRO equipment complex: a gamma-ray telescope with spark chambers for research in the range from 20 MeV to 5 BeV, a component part of which--the NaI(Tl) polycrystal, 76x76 cm² in area, with thickness of 20 cm and mass of 535 kg--provides for an energy measurement accuracy of up to 15 percent; a precision gamma-ray spectroscopy with 18 cooled crystals of super-pure germanium, each of which has a diameter of 6.5 cm and length 5 cm; a gamma-ray telescope for intermediate energies up to 10 MeV which operates on the principle of the Compton effect; a set of 12 NaI(Tl) disks, each 48 cm in diameter, for research on gamma-ray bursts.

Research conducted on board space observatories is allowing substantial progress to be made in understanding a number of astrophysical phenomena. But even today it is clear that we must begin developing the principles of gamma-ray telescope construction of the next generation, with angular resolution on the order of minutes and measurement accuracies for gamma-ray quanta energies at least to the level of units of a percent over the broad energy spectrum. These are exceedingly difficult tasks, but their accomplishment will enable us to take the next step in assimilating knowledge of the universe.

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CSO: 1866/154

ADVANTAGES OF SPACE STATIONS AT THE EARTH-MOON LIBRATION POINTS

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 7, Jul 81 pp 42-43

[Article by Professor A. Brykov, doctor of technical sciences, Lenin Prize laureate, RSFSR Honored Worker in Science and Technology: "A Station at a Libration Point"]

[Text] In articles published in this magazine, different authors have repeatedly presented facts that indicate convincingly that cosmonautics is actively assisting in the development of science, technology and the national economy and is causing accelerated technical progress. It undoubtedly has a great future. Today it is difficult even to visualize the entire set of technical and national economic problems that will be solved through the use of space technology. This article is concerned with some of the possibilities of future cosmonautics, in particular with the use of space in the area of the libration points of the Earth-Moon system.

In theory, the concept of libration points appeared long ago. The Law of Universal Gravitation, discovered by Newton, enabled scientists to predict the movements of the planets. However, the attempt to predict the Moon's motion with the degree of accuracy that was needed did not meet with success. The fact of the matter is that the Sun has a substantial effect on the motion of our natural satellite around the Earth. Thus, scientists were faced with solving a three-body problem: the Sun, the Earth and the Moon. It should be mentioned here that this problem still has not been solved in final analytical form. Euler and Lagrange merely found several special cases.

Euler's and Lagrange's investigations, which for a long time were regarded as being only beautiful theoretical constructs, are today of great practical significance. Many automatic interplanetary stations move within the gravitational field of the Earth and the Moon. In these cases we are dealing with a limited three-body problem. As Euler and Lagrange demonstrated, its special solutions determine the coordinates of five points that have unique properties. They are called librational (or simply libration points). Why are they noteworthy? A space station (a material point with a negligibly small mass in comparison with the Earth and the Moon) located in the vicinity of a libration point will move there forever, maintaining a completely determined, forever unchanging position relative to the two attracting centers. This means that the process of controlling the spacecraft's motion is simplified and the volume of required navigational metering information is reduced. Besides this, the need for systematic presentation of target designations by the measuring systems and control points is eliminated. There is also a reduction in the number of operations related to orbit determination, the making and monitoring of corrections and predicting the spacecraft's motion.

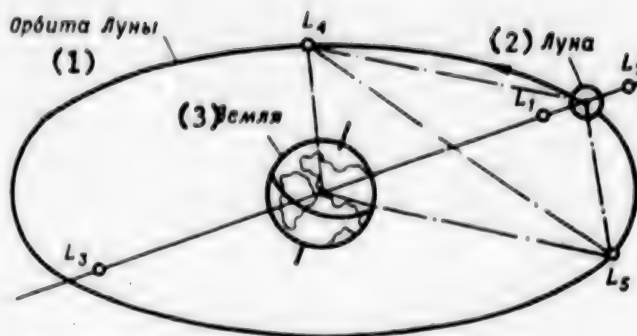


Figure 1. Location of libration points in the Earth-Moon system.

Key: 1. Orbit of the Moon
2. Moon
3. Earth

In the Earth-Moon system, libration points L_1 - L_5 are located in the plane of the Moon's orbit (Figure 1). Three of them (called the collinear points) are situated on the straight line passing through the centers of mass of the Earth and the Moon. If the distance between the Earth and the Moon at any moment is designated as r , the distance from the Earth to the first point is always characterized by a distance that is $\sim 0.849r$. The second is located beyond the Moon, at a distance from it of $\sim 0.169r$. The third is located on the other side of the Earth, at a distance from it of $\sim 0.992r$. The fourth and fifth points are situated so that, in the plane of the

Moon's orbit, a rhombus is formed with sides of length r , at the apices of which are the Earth, L_4 , the Moon and L_5 (two equilateral triangles). They, therefore, are called the triangular libration points.

It is noteworthy that all the libration points strictly maintain their own completely determined position in the Earth-Moon system. There is yet one more astonishing property: in the ideal case, a space station placed at one of these points with small initial perturbations will make oscillatory motions near it (hence the name "libration") for a long time. As time passes, a station will then leave the area of the collinear points. As far as the triangular ones are concerned, in their vicinities a station's motion will continue forever. In view of this, the first, second and third points are categorized as unstable, while the fourth and fifth are stable libration points. This is from the point of view of theory. Under real conditions, when acted upon by perturbations (the Sun's gravitational field, the eccentric nature of the Earth's and Moon's gravity field, the pressure of the solar wind and several other factors), in time a station will move away from the vicinity of any of the libration points. However, in view of the smallness of these perturbations, a station can be kept there easier, with considerably smaller expenditures of energy, than at any other point in space in the Earth-Moon system.

Let a station be located in the vicinity of the first point. In the station's control system there is equipment registering its distance from the Earth (or Moon). As soon as this distance exceeds a given value, a correcting engine is turned on. A total thrust of only 20 m/s is required to keep a station within 15 km of the first point for a period of 1 year.

There are more favorable conditions in the neighborhoods of the triangular points. In order to keep a space station there, additional expenditures of energy may not be required. The effects of the disturbing factors can be compensated for by the appropriate choice of the initial conditions, and for several years there will be no need for corrections. The station will move in the vicinity of the fourth (or fifth) point for a long time, in the plane of the Moon's orbit for all practical purposes, in a so-called stable orbit (with the station at a distance of 20,000 km in the Earth-libration point direction and no more than 40,000 km in the perpendicular direction).

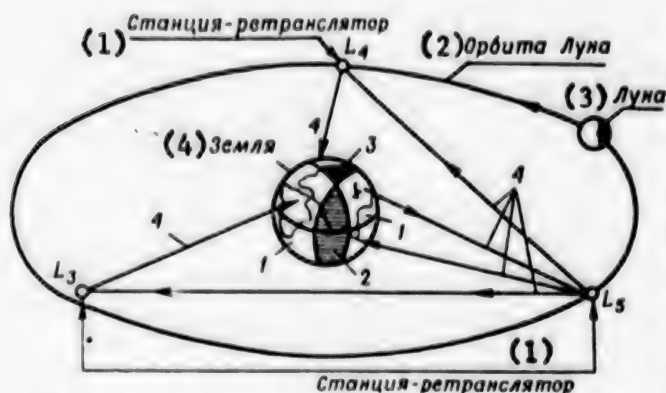


Figure 2. Diagram for global communications using libration points L_3 , L_4 and L_5 : 1. field of vision of one retransmitter; 2. field of simultaneous vision of two retransmitters; 3. zone with lack of communication; 4. information transmission paths.

Key: 1. Retransmitting station
2. Orbit of the Moon
3. Moon
4. Earth

The utilization of space in the vicinities of the triangular fourth and fifth libration points is the most promising. There there is no atmosphere, which is one of the basic factors limiting the possibilities for astronomical and astrophysical observations from Earth. For all practical purposes there is no magnetic field or radiation belts, which make it difficult to study emissions of charged particle flows with artificial Earth satellites in near space. The duration of continuous observations of objects in space in any direction is almost unlimited. The constant presence of the Sun simplifies the solution of the problem of supplying a space station with electricity.

The placement here of long-base radio-interferometers (with a base about 700,000 km long) will provide extensive opportunities for studying explosive processes in galactic nuclei and

stars, the properties of intergalactic gas and the distribution of matter in our galaxy, as well as making it possible to carry out other basic research. Further investigations of phenomena taking place on the Sun is a matter of huge scientific and practical interest, since they have a substantial effect on vitally important processes occurring on our planet. The exacerbation of cardiovascular disease, changes in people's blood composition, fluctuations in the animal, fish and bird populations, the annual growth of trees, changes in crop yields, atmospheric circulation, the number of magnetic storms, the level of lake and ground water, the number and severity of earthquakes--all of these things are directly dependent on solar activity. The exact prediction of it will make it possible to prevent the negative consequences of many of these phenomena to a considerable extent.

By using the properties of the first collinear libration point, the expenditure of energy for expeditions to the Moon can be reduced significantly. In addition to this, in its vicinity it is possible to built an intermediate base at which technical facilities and fuel for the return of expeditions to Earth can be concentrated.

Space in the neighborhood of the second point is also of practical interest. It can be used to solve the problem of communicating with stations carrying out research on the other side of the Moon. In order to do this, in the area of the point there must be a retransmitter placed so that it is simultaneously visible from Earth and the other side of the Moon. In order to keep a spacecraft there, periodic corrections of its motion will be necessary. Calculations show that in order to do this for a year, the total thrust corresponds to a characteristic velocity of about 200 m/s.

The idea of using the libration points for the creation of a global communication system on Earth (Figure 2) is extremely tempting. In this case, retransmitting

stations are placed in stable orbits in the vicinities of the fourth and fifth points, as well as near the third one. A triangle with sides about 700,000 km long, at the apices of which the retransmitters are located, is then created in the plane of the Moon's orbit. In connection with this, at least one of them will be visible from a large part of the Earth for days on end. This means that it would be possible to transmit information to any point on Earth. The only exception will be the polar areas near the poles, where for several days each month information can be delivered with a delay of up to 4 hours.

Thus, space near the libration points in the Earth-Moon system has a number of remarkable properties that can be used successfully for the effective solution of scientific and national economic problems.

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11746

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ANALYSIS OF SIMPLIFIED MODEL OF OPTIMUM TRANSFER BETWEEN ORBITS WITH LIMITATION ON FLIGHT TIME

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 5 Jun 80)

IVASHKIN, V. V.

[Abstract] The author discusses the problem of determining the optimum (with respect to minimum characteristic velocity) three-burn transfer between circular orbits in a central, Newtonian gravitational field when the flight time is limited. Given no time limitation, the optimum transfer flight is biparabolic, while with some limitation on the distance to the center of attraction, it is a three-burn apsidal transfer. The author uses a simplified model utilizing solutions different from the apsidal solution 1) with respect to the maximum distance from the spacecraft to the center of attraction and 2) with respect to the orientation of velocity V_2^+ or the magnitude of the true anomaly ϑ_2^+ after the second burn. He then proceeds to a numerical determination of the optimum transfer within the framework of this model and gives an approximate analytical definition of its parameters. Figures 8, references 3: 2 Russian, 1 Western. [133-11746]

MOTION OF SPACECRAFT WITH FLEXIBLE SOLAR BATTERY PANELS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 11 Dec 79) pp 336-345

KHOROSHILOV, V. S.

[Abstract] The author examines this problem proceeding from the assumption that a spacecraft consists of a carrying solid body (the ship) and carried bodies (flexible solar panels). He sets up the equations of motion of the spacecraft and the solar battery panel oscillations and then examines the natural forms and frequencies of the panel oscillations. After finding the approximate values of these frequencies, the author solves the spacecraft's equations of motion and

makes numerical calculations for a panel 10 m long. The methods employed make it possible to determine panel parameters (geometrical and inertial characteristics, in particular) on the basis of a requirement for a given panel oscillation frequency. Figures 3; references 6: 4 Russian 2 Western.
[133-11746]

UDC 629.7.015.3

ADAPTIVE ALGORITHMS FOR CONTROLLING DESCENT IN EARTH'S ATMOSPHERE OF SPACECRAFT WITH GOOD AERODYNAMIC QUALITIES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 26 Mar 80) pp 359-366

BALAKIN, V. L. and MOROZOV, L. B.

[Abstract] When constantly acting disturbances are present, a linear correction control algorithm for controlling the descent of a spacecraft to a specific landing area may not give satisfactory results. The authors investigate quasi- and non-linear adaptive descent control algorithms for a spacecraft with good aerodynamic qualities. The control strategy used is: when the landing point is located inside the area of achievability, the bank angle command program is determined from the condition of zero deviation of the predicted landing point from the given one; when it is outside the area of achievability, the initial condition is minimum deviation. The authors find that a quasilinear algorithm works better when the landing point is inside the area of achievability (with an accuracy of least 1 km), while when it is outside it, a nonlinear algorithm works better (error does not exceed 3-5 km). Figures 8; references 3.
[133-11746]

UDC 629.78

INVESTIGATION OF DIRECT FLIGHT TRAJECTORIES TO PERIODIC COMETS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 22 Oct 80) pp 377-391

KAZAKOVA, R. K., KOTIN, V. A., PAPKOV, O. V., PLATONOV, A. K. and SUKHANOV, K. G.

[Abstract] The authors investigate the characteristics of the optimum flight trajectories to different short-period comets with reliably determined orbital elements and determine the starting dates for optimum-trajectory flights to 16 comets (including Halley's) from 1985 to 1991. They discuss the requirements for flights when the comets are at perihelion and aphelion, as well as the effectiveness of correcting maneuvers. Their conclusions are: 1) there exist

favorable conditions for flights to one or several comets every year; 2) for reconnaissance (fly-by) purposes, flights to perihelion are preferred; 3) for investigative (accompanying) purposes, flights to aphelion are more energy efficient. Figures 14; references 11: 7 Russian, 4 Western.
[133-11746]

UDC 537.525.1

EFFECT OF INDUCED ELECTRODYNAMIC FORCE ON PARAMETERS OF ION SCREEN AROUND CYLINDRICAL, LOW-FREQUENCY ANTENNA IN THE IONOSPHERE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 3 Jun 80) pp 392-400

AKSENOV, V. I., MODESTOV, A. P. and KHATSKEVICH, I. G., deceased

[Abstract] The authors study the effect of induced electrodynamic force on the conductance and capacitance of the ion screen around a low-frequency, cylindrical, electric antenna in the ionosphere and compare the results of their calculations with experimental data obtained by the "Intercosmos-Kopernik 500" satellite, where a low-frequency impedance meter was used to measure the input resistance of an antenna of this type at a frequency of 50 kHz. They analyze the effects of induced electrodynamic force on an ion screen's parameters, present the results of the actual conductance and capacitance measurements and, after comparing the two sets of results, conclude the following: 1) the screen's conductance and capacitance increase as the induced electrodynamic force does, with this effect being manifested more strongly as the ionospheric plasma's electron temperature decreases; 2) the electrodynamic force induced in an antenna is the basic factor determining the dependence of a low-frequency electric antenna's impedance on its spatial orientation; 3) along with the parameters of the ionospheric plasma, it is necessary to have information on the orientation of the satellite's axes relative to the direction of the geomagnetic field and the satellite's velocity vector. Figures 3; references 10: 6 Russian, 4 Western.
[133-11746]

UDC 519.23

RADIAL SYSTEM OF TETHERED SATELLITES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 19, No 3, May-Jun 81
(manuscript received 14 Dec 79) pp 467-470

POLYAKOV, G. G.

[Abstract] The author discusses a system of two satellites tethered by a cable or line carrying a useful load (a wire, special coatings, a transportation system). Beginning with equations for the potential of the gravitational-inertial

field and the algebraic values of its strength, he derives equations for the elements of such a system and discusses the case in which a tethered system is deployed from a "Salyut" - "Soyuz" - "Progress" complex. References 8:

4 Russian, 4 Western.

[133-11746]

UDC 522.62:681.31

SOFTWARE FOR SUPERLONG-BASE INTERFEROMETRY BASED ON UNIFIED-SERIES COMPUTERS

Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 58, No 4, Jul-Aug 81

(manuscript received 28 Apr 80) pp 898-903

KOGAN, L. R. and CHESALIN, L. S., Institute of Space Research, USSR Academy of Sciences

[Abstract] After giving a brief history of long-base interferometry, the authors describe an information processing algorithm developed for use with computers in the Unified Series. The algorithm makes it possible to process signals from sources that emit both a continuous spectrum and spectral lines. It is written in the "Assembler" language and features Fourier analysis on both the primary and secondary processing levels. The authors explain its operation and present the results of an experiment conducted with it in 1979. Figures 1; references 11: 7 Russian, 4 Western.

[3-11746]

UDC 528.5

USING ANNULAR LAYER OF SEALING COMPOUND FOR RELIEVING STRESSES IN HIGH-PRECISION MIRROR FOR SATELLITE GEODESY INSTRUMENTS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKO

in Russian No 2, Mar-Apr 81 (manuscript received 8 Jul 80) pp 102-111

VOSKRESENSKIY, L. L., candidate of technical sciences

[Abstract] Rubber cements of the sealing compound type have begun to be used more frequently for fastening optics in mounts. This method makes it possible to reduce considerably the strain on the optical element from the effect of its own weight and to improve the strength of its fastening in the mount. According to one method, the concentric gap between the optical element (a lens or mirror) and the mount is filled with a sealing compound which forms an elastic ring whereby the cylindrical surfaces are fastened strongly to the adjacent surfaces of the mount and the element. This method should provide more effective relief of stresses than use of a flexible strip, since in the former case the relieving stresses should act over the entire circumference of the mirror. A theoretical

comparison of the effectiveness of both methods is made here. A solution is found to the problem of the straining of a mirror in the form of a disk in an annular elastic layer, employing methods of the plane theory of elasticity. First, a solution is found to the problem of the straining of an elastic ring contained between an absolutely rigid mount and disk. Then a determination is made of the straining of a mirror loaded in its plane by forces of gravity and mounting forces on its circumference. The distribution and magnitude of these forces are found in the first part of the problem. A comparison is made between the relief of stresses for a mirror supported by a flexible strip and one in an elastic ring. Using an annular layer of sealing compound makes it possible to relieve stresses by means of a combination of radial and tangential forces acting outward along the entire circumference of the mirror. Distortion of the optical surface of the mirror does not result, thus eliminating wave aberrations in the reflection of a light wave from the mirror. The birefringence originating when the disk is fastened in the elastic ring has axial symmetry, because of which axisymmetric distortion of the wave front of a beam passing through the disk takes place, and can be corrected. By proper selection of the geometrical dimensions and mechanical characteristics of the material of the elastic ring it is possible to reduce the amount of transverse straining of the ring and of birefringence. A distribution of stresses in the disk which has practically no influence on its optical homogeneity can be achieved by proper selection of the thickness of the ring and of the sealing compound's Poisson ratio.

Figures 4; references 4 Russian.

[158-8831]

SPACE APPLICATIONS

UDC 330.15(15)

EXPERIMENTS IN STUDYING EARTH'S NATURAL RESOURCES FROM 'SALYUT-6' ORBITAL STATION

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 81 pp 21-26

ARKHIPOV, V. V., DESINOV, L. V., ZLOBIN, L. I., KOVAL', A. D. and FILIPCHENKO, A. V.

[Abstract] A great deal of natural resource research was carried out by the different crews during the extended flight of the "Salyut-6" orbital station. The first expedition took place during the Northern Hemisphere's winter and the rest during the summer, which provided materials for contrast and comparison. The research program was also adjusted on the basis of the results of each expedition. The medium-format topographical camera chosen for this work was the KATE-140, while the MKF-6M (an improved version of the MKF-6) was used for multizonal surveying. Visual observations were also made, using hand-held equipment. The basic areas and fields of attention of each expedition are outlined.

[148-11746]

UDC 528.73:528.711.1(202)

CONSTRUCTION OF REFERENCE NETWORKS ON PLANETS AND THEIR SATELLITES ON BASIS OF SPACE PHOTOGRAPHS

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 81 pp 26-30

TYUFLIN, Yu. S.

[Abstract] The author reviews the status of the formulation of reference networks on the planets and satellites, including those for which sufficient materials are available but which have not yet had coordinates and reference points published. He discusses the mapping of the Moon in considerable detail and the mapping of Mars, Mercury, the Jovian satellites and Phobos in less detail. There is also some discussion of the placement of prime meridians. References 22: 11 Russian, 11 Western.

[148-11746]

USING SHORT ARCS IN SPACE TRIANGULATION

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 81 pp 30-32

USTINOV, G. A. and KAPILEVICH, D. I.

[Abstract] The authors mention several methods for determining a satellite's position by space triangulation, but reject them as being formalized processes not reflecting the true physical situation. The use of a group of parameters that correspond to a satellite's true motion and are constant for a given group of synchronous photographs is suggested. Starting with the Mayyer and centrifugal force potentials, kinetic energy and the Earth's gravitational potential, they derive the equations of motion for a satellite and then demonstrate how to compute its position. References 2: 1 Russian, 1 Western.
[148-11746]

UDC 528.34.088:629.78

RELATIVISTIC EFFECTS IN DOPPLER MEASUREMENTS

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 81 pp 33-36

TOKAREV, A. V.

[Abstract] In satellite geodesy, relativistic effects that appear in Doppler measurements are the result of the relative motion of the signal transmitter and receiver, as well as the difference in the gravitational potentials at the points where the satellite and the tracking station are located. The author presents an equation that takes these factors into consideration when determining the frequency of a received signal and refines it for the frequencies most widely used in satellite geodesy. He also discusses sources of error and how to compensate for them. His final equations allow for the relativistic effects with an accuracy of 0.01 Doppler cycle. References 3.
[148-11746]

AUTOMATING PROCESSING OF SPACE VIDEO INFORMATION

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 81 pp 37-41

DYNKIN, A. M., ZLOBIN, L. I. and SOLOMATIN, M. Ye.

[Abstract] The interbranch complex for the automated processing of space information that is now being organized will operate on two levels: on the first, high-productivity interbranch processing complexes based on high-productivity computers are used; on the second there are specific complexes based on mini-computers and specialized microprocessors and peripheral equipment. The realization of this complex requires the solution of a number of problems: 1) the creation of automated equipment for computer input and output of photographic images, graphic information and accompanying data; 2) the improvement of the technology for the digital transformation of space photographs and the compilation of photographic maps; 3) the processing of multizonal video information; 4) the improvement of automated interpretation on the basis of interactive video information processing; 5) the creation of cartographic output based on data obtained by the automated processing of space video information; 6) the organization of digital processing on a systems basis.

[148-11746]

UDC 528.711.1(202):63

USING SPACE SURVEYS IN AGRICULTURAL RESEARCH

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 81 pp 46-48

ZALETOV, A. A., SAMRATOV, U. D. and SUKHOT'KO, N. V.

[Abstract] The question of large-scale mapping of land resources from space photographs has not received much attention. The All-Union Institute of Agricultural Aerial Photographic Geodesic Research and the State Scientific Research Institute of Land Resources have completed several experimental production projects concerning the interpretation of space photographs and the production of photographic maps on the basis of data obtained from them. The maps were then collated with maps derived from aerial photographs. The areas covered were part of the Mongolian People's Republic, a region in the Non-Black-Earth Zone, and a region with grain crops. The authors explain the advantages of using space technology in this field, one of the main ones of which is the speed with which large areas can be surveyed.

[148-11746]

USING SPACE SURVEY MATERIALS IN GEOLOGICAL RESEARCH

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 81 pp 48-52

MEZHELOVSKIY, N. V. and BRYUKHANOV, V. N.

[Abstract] The authors give a brief history of the use in geological research of materials obtained in space and then describe the achievements in this field in the 10th Five-Year Plan: the creation of specialized space-geology maps (geological, tectonic, mineragenic and others); the supplementing of geological maps obtained by traditional methods with structural elements detected in space survey materials; predictive and prospecting work for different types of useful minerals; the solution of general geological problems related to the history of the development and structure of the Earth and the other planets. Examples of each type of work are given.

[148-11746]

UDC 528.711.1(202)+(203):626.81

CONTROLLING WATER RESOURCES ON BASIS OF INFORMATION OBTAINED BY REMOTE MEANS

Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 4, Apr 81 pp 57-60

LEONIDOV, V. A.

[Abstract] Using the Syrdar'ya River and the South Golodnostepskiy Canal as examples, the author lists the parameters that must be measured in order to implement an automatic water resource control system, along with factors relating to the measurements: periodicity, allowable time lag in delivering the information, resolution, scale and accuracy. Some of the technology for obtaining the necessary information by aerial or space methods has been developed, while other parts of it are still being worked out by various ministries and research institutes. References: 5.

[148-11746]

USING SPACE PHOTOGRAPHS OF EARTH TO STUDY STRUCTURE OF DEGASIFICATION ZONES IN GAS- AND OIL-BEARING BASINS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 26 Dec 80) pp 5-10

AMURSKIY, G. I. and BONDAREVA, M. S., All-Union Scientific Research Institute of Natural Gasses, Moscow

[Abstract] The authors used multizonal, synthesized, color and black-and-white medium-scale space photographs in an attempt to interpret faults in three areas in Central Asia that have different geotectonic conditions but have in common the fact that they are all located in highly promising gas and oil basins with explicit indicators of abundant presence of hydrocarbons even though no industrially exploitable deposits have yet been found. Black-and-white and synthesized space photographs proved to be the most informative. Space photographs make it possible to follow the traces of dislocations with breaks in continuity throughout their entire length, which is usually not possible when geological and aerial-photography methods are used. The authors distinguish features in the photographs of these three areas, compare them with known geological facts, and extend them to areas not yet studied in detail. Figures 3; references 6.
[140-11746]

RING STRUCTURES OF PRE-CAMBRIAN SHIELDS, ACCORDING TO DATA OBTAINED BY INTERPRETING SPACE PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 22 Jan 81) pp 18-22

MORALEV, V. M. and GLUKHOVSKIY, M. Z., Lithosphere Institute, USSR Academy of Sciences, Moscow, and "Aerogeologiya" Geological Production Association, Moscow

[Abstract] The authors use low-resolution scanning space photographs taken by the "Meteor" system to study two types of ring structures that were revealed on the Baltic and Aldan shields inside the USSR. The first type includes complex circular elements 900-1,200 km in diameter, usually having a concentric ring structure. They are always made more complex by the presence of smaller ring structures and, as a whole, form complex ovoid-ring structures. The second type consists of ring structures 50-400 km in diameter that are, at the same time, more diversified than the first type as far as photographic features are concerned and simpler in overall structure. The authors believe that the structures of the first type are ancient volcanic-sedimentary accumulation basins, while those of the second are foci of granite formation and magmatic diapirism. Figures 1; references 5.
[140-11746]

SPACE RESEARCH IN SEISMICALLY ACTIVE REGIONS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 18 Aug 80) pp 28-34

KHOVANSKIY, B. N., "Priroda" State Scientific Research and Production Center

[Abstract] Information obtained by space photography and used in earthquake prediction research is used in three areas: geological-geomorphological, geophysical and geodesic. The first is used to find seismogenic zones, the second to determine the length and direction of faults, and the third to detect long-term indicators of upcoming seismic activity. The author gives several examples of the use of space information in seismic research in Central Asia. Figures 4; references 10.

[140-11746]

UDC 551.46:528.7

RESULTS OF CALCULATING TRANSMISSION FUNCTIONS OF OZONE LAYER IN 9.6-MICRON BAND OF SPECTRUM, USING DIRECT LINE-LINE METHOD

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 17 Oct 80) pp 56-65

VARNAVA, V. A. and KARASEV, A. B., Moscow Physicotechnical Institute, Dolgoprudnyy

[Abstract] Remote determination of the atmosphere's ozone content is made more complicated by inaccuracies in determining the atmosphere's transmission function in the 9.6- μm band. The authors propose a new approach--the direct line-line method--for calculating transmission functions in the infrared band, compare theoretical and experimental values of the transmission function in the 9.6- μm band, and reach the following conclusions: 1) with the introduction of an additional correction factor, the available data on the spectrum's fine structure gives a satisfactory description of absorption in the long-wave part of the band; 2) further improvements in accuracy require a knowledge of the shape of the O_3 lines' limbs, a more nearly accurate allowance for the effect of weak lines, and additional high-accuracy experiments; 3) the spectral transmission functions of ozone are almost completely independent of the temperature profile; 4) the altitude of the ozone layer has a substantial effect on the transmission function; 5) on the basis of a comparison of theoretical and experimental results, it is advisable to use the section of the 9.6- μm band that is centered on $1,020\text{ cm}^{-1}$. Figures 8; references 12: 5 Russian, 7 Western.

[140-11746]

SIGNAL-TO-NOISE RATIO OF SPACE PHOTOGRAPHY SYSTEM

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 4 Dec 80) pp 66-76

MATYASEVICH, L. M., "Priroda" State Scientific Research and Production Center

[Abstract] The author attempts to clarify the concept of signal-to-noise ratio for an earth resources space photography system by defining signal and noise characteristics and relating them to each other. He then applies this concept to a theoretical space photography system and concludes that it offers extensive possibilities for improving the information content of the photographs provided by such a system, although much theoretical and practical work remains to be done before this can be realized. Figures 3; references 11.

[140-11746]

POSSIBLE INCREASE IN SPECTRORADIOMETRIC ACCURACY IN REMOTE INVESTIGATIONS OF EARTH WITH MULTIZONAL SURVEYING SYSTEMS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 28 Nov 80) pp 77-84

BOGDANOV, A. A., NALIMOV, V. N., SYCHEV, A. G., TARNOPOL'SKIY, V. I. and TOLSTYKH, G. N., Institute of Space Research, USSR Academy of Sciences, Moscow, and All-Union Scientific Research Institute of Optical Physical Measurements, Moscow

[Abstract] The authors use approximation methods to reduce the indeterminacy related to the fact that the spectral composition of an object being measured and that of the measuring instrument's standard are normally not identical. The relationship between the latter's output reaction and the spectral density of the former's energy brightness is almost always indeterminate. Their technique involves determining the relative spectral sensitivity functions of each surveying system channel and the values of the output signals of each of the channels from a reference source, which enables the distribution of the spectral density of the investigated object's energy brightness in the spectral operating band of the system to be determined. Figures 4; references 7: 6 Russian, 1 Western.

[140-11746]

EVALUATING RELIABILITY OF INFORMATION FROM SEVERAL SOURCES IN PROBLEM OF SURVEYING EARTH

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 3 Jul 80)

NESTERENKO, O. P., SMOL'YANINOV, Yu. A. and NADBEREZHNYI, S. D.

[Abstract] The authors develop a technique for evaluating contradictory information from different space sources based on the Bayes approach and the assumption that the sources are independent. Using provisional probabilities, they set up an information matrix for an arbitrary source, whereupon the problem becomes one of constructing an algorithm to obtain an estimate of the probability of a true solution. They then explain the solution technique and present some results of its application, which is sufficiently simple to be realized with a digital computer. Figures 1; references 2.
[140-11746]

UDC 629.783:778.39

CRITERION FOR EFFECTIVENESS OF SPACE COMPLEXES FOR STUDYING EARTH'S NATURAL RESOURCES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 30 Sep 80) pp 89-95

AVDUYEVSKIY, V. S., ASTASHKIN, A. A., SAUL'SKIY, V. K. and USPENSKIY, G. R.

[Abstract] The authors combine such factors as increased income, prevented loss and difference in cost of construction of terrestrial and space facilities to devise a formula for determining the effectiveness of the utilization of space facilities to study the earth's natural resources. They then apply their final formula to three arbitrary space complexes and find that it is satisfactory, i.e. it is sensitive to differences in the systems. Figures 5; references 11: 8 Russian, 3 Western.
[140-11746]

BASIC PROBLEMS AND METHODS FOR OPERATIONAL PLANNING OF EXPERIMENTS FOR INVESTIGATING EARTH FROM SPACE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 26 May 80) pp 96-101

BELYAYEV, M. Yu.

[Abstract] Many factors have to be controlled in conducting experiments in space involving investigation of the Earth, but such a program can be broken down into two stages: 1) development work and selection of objects to be investigated; 2) choice of the optimum time for conducting experiments during a flight and the specifics of their implementation. Factors that must be taken into consideration during operational planning include: 1) Sun height; 2) seasonal changes; 3) amount of time available at what time of day; 4) meteorological conditions in the area being surveyed. Operational planning itself involves the solution of the following problems: 1) finding the moment when the spacecraft is in the proper position over the area to be surveyed; 2) finding the moment when the distance to the satellite is minimal; 3) given a number of regions, find the optimum periods for conducting experiments; 4) given several large-scale regions, determine the proper period for maximum coverage; 5) given a region, find the moment of optimum observation conditions. These problems are usually solved with the help of numerical integration of the spacecraft's differential equations of motion by the method of direct sorting of possible variants in the research program's structure. The author also mentions several methods for accelerating the computation process. Figures 2; references 5.
[140-11746]

UDC 528.72+528.55

GEOLOGICAL INTERPRETATION IN DIALOG MODE IN AUTOMATED DIGITAL IMAGE PROCESSING SYSTEMS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 7 Jul 80) pp 102-112

BELIKOVA, T. P., GENDLER, V. Ye. and YAROSLAVSKIY, L. P., Institute of Information Transmission Problems, USSR Academy of Sciences, Moscow, and "Aerogeologiya" Geological Production Association, Moscow

[Abstract] Since there are no formalized indicators for the geological interpretation of space photographs, the only way to do high-quality work with them is to use automated systems that can transform them according to rules of interest to the geologist doing the interpreting. The authors discuss the brightness characteristics of geological objects and features of their interpretation on space photographs, adaptive mode quantization, and exponential intensification

of photograph shadings. They conclude that the use of the dialog method improves both the quality and the quantity of the information obtained from these photographs and state that it has been used in space photogeological mapping on a scale of 1:1,000,000 and aerial photogeological mapping on a scale of 1:200,000 that has been done by the "Aerogeologiya" Association. Figures 6; references 6. [140-11746]

UDC 528.72(202):621.397.6

DEVICE FOR STORING AND PRESENTING DIGITALIZED IMAGES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 81
(manuscript received 11 Feb 80) pp 115-117

MIKHAL'TSOV, E. G., SHAKIROV, R. A., KOMPAN'KOV, B. V., GUREYEVA, O. N. and KOLODEY, V. V., Special Design Office of Scientific Instrument Building, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] The authors describe a collection of equipment that makes it possible to receive digital half-tone images, store them and make high-quality reproductions on black-and-white and color television monitors. The basic computer used is an "Elektronika-60," which has an enlarged memory (12K 16-letter words). The other elements of the equipment complex consist of a control interface, a synchronizing generator, a regenerative memory and its controller, a permanent memory unit (programmable from the computer) consisting of 3 modules with a capacity of 256 x 8 bits each, digital-to-analog converters and television monitors capable of handling an image with 512 x 512 elements at a scanning rate of 25 frames per second. Figures 1; references 3: 2 Russian, 1 Western. [140-11746]

UDC 528.2 : 629.78

RESONANCE ORBITS OF ARTIFICIAL EARTH SATELLITES AND THEIR EMPLOYMENT IN DYNAMIC PROBLEMS OF SPACE GEODESY

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA in Russian No 2, Mar-Apr 81 (manuscript received 6 Dec 79) pp 36-42

YASHKIN, S. N., assistant professor and candidate of technical sciences, Moscow Order of Lenin Institute of Geodesy, Aerial Photography and Cartography Engineers

[Abstract] The possibilities of using the resonance orbits of artificial earth satellites in studying the fine structure of geopotential have not been fully utilized. The serious mathematical difficulties encountered in the attempt to do so can be overcome by enlisting the fundamental ideas of the Kolmogorov-Arnold-Moser theory in plotting and studying the resonance orbits of artificial earth satellites. The discussion begins with the expression for the perturbation

function of geopotential giving rise to perturbed motion in the generalized problem of two stationary centers: $u' = -\alpha_1 + R$, where α_1 is the intermediate potential providing Eulerian motion with elements a, e, i, ω, M and Ω . Differential equations of motion are presented in Hamiltonian form. The perturbation function is presented in canonical variables. Resonance phenomena are discussed in the canonical system of differential equations of motion. A proof is given for a theorem which substantiates the approach used in the Kolmogorov-Arnold-Moser theory in solving the problem of trivial denominators, i.e., strict commensurability is excluded from consideration. References 7: 6 Russian, 1 Western.
[158-8831]

UDC 528.2 : 629.78

DETERMINING METHODICAL ERROR IN NUMERICAL INTEGRATION OF EQUATIONS FOR PERTURBED MOTION OF ARTIFICIAL EARTH SATELLITES IN ORBITAL METHOD OF SPACE GEODESY

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA
in Russian No 2, Mar-Apr 81 (manuscript received 22 Sep 80) pp 42-45

STEPIN, Yu. D., graduate student, Moscow Order of Lenin Institute of Geodesy, Aerial Photography and Cartography Engineers

[Abstract] In the orbital method of space geodesy it is necessary to know the error in determining the coordinates of a satellite due to the methodical error in numerical integration of the equations of motion for satellites. In this method the position of the satellite is determined from known initial elements of the orbit and a model of perturbing forces is used. A precise analytical solution to this problem is impossible in the case of perturbed motion, but the methodical error can be reduced by using highly accurate numerical integration algorithms. A method is described for obtaining a methodical error which can be used as a criterion for selecting a specific algorithm. As applied to the orbital method of short arcs for estimating the total methodical error in numerical integration of equations of perturbed motion it is demonstrated that it is sufficient to know the methodical error in solving the "unperturbed" problem. By multiplying this value by the value of the minor perturbation parameter the error resulting from the influence of the perturbation half is obtained. An equation is derived for comparing the accuracy of various methods of numerical integration and for finding the total methodical error in numerical integration of equations of perturbed motion. References 6: 5 Russian, 1 Western.
[158-8831]

USING SEVERELY ELONGATED SATELLITE ORBITS TO SOLVE SPACE GEODESY PROBLEMS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA
in Russian No 1, Jan-Feb 81 (manuscript received 31 Mar 80) pp 56-61

STEPOCHKIN, A. A., graduate student, Moscow Institute of Engineers of Geodesy,
Serial Surveying and Cartography

[Abstract] The author demonstrates that when a severely elongated satellite orbit is used to obtain geodesic data, the value of the radius of convergence of the expansions of the satellite's coordinates with respect to the degrees of the integration step should be taken into consideration during the numerical integration of the satellite's equations of motion. He also investigates the accuracy of the numerical integration of these equations as a function of the orbit's eccentricity and the initial conditions of motion and reaches the conclusion that the greater the eccentricity of the orbit, the smaller the integration step should be. Figures 8; references 2.

[147-11746]

UDC 528.7

INVESTIGATION OF ILLUMINATION IN IMAGE PLANE OF RECEIVING OPTICAL SYSTEM DURING AEROSPACE SURVEYING OF AREAS OF OCEAN WATER

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA
in Russian No 1, Jan-Feb 81 (manuscript received 8 Aug 79) pp 73-82

POLOVINKO, V. V., candidate of technical sciences, Moscow Institute of Engineers
of Geodesy, Aerial Surveying and Cartography

[Abstract] Since the illumination in the image plane of an optical instrument's receiving optical system is the information that reaches the investigator in analog or digital form and, at the same time, is the same as the brightness of the emissions of the atmosphere and the ocean, it is necessary to develop brightness models of aerospace surveying in order to interpret the information that is obtained. In order to do this, it is necessary to establish the relationship between the distribution of the illumination in the image plane and the optical characteristics of the natural mediums. The author discusses this in relation to the visible, infrared and thermal bands of the spectrum and derives equations that can be used for the mathematical modeling of optical surveying of water areas in the world ocean and to develop methods for measuring the characteristics of natural waters with aerospace technology means. Figures 2; references 10: 9 Russian, 1 Western.

[147-11746]

USING SPACE PHOTOGRAPHS IN TOPOGRAPHICAL CARTOGRAPHY

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA
in Russian No 1, Jan-Feb 81 (manuscript received 11 Feb 80) pp 95-102

VERESHCHAKA, T. V., candidate of geological sciences, reader, Moscow Institute of Engineers of Geodesy, Aerial Surveying and Cartography

[Abstract] It is widely believed that space photographs are best used to compile, update and refine the contents of general topographic and photographic maps with scales of 1:300,000-1:1,000,000, although high-resolution photographs with large scales can sometimes be used to refine maps with smaller scales. There are four basic areas in which space photographs can be used in topographical cartography: formulating technical plans for mapping projects; interpreting aerial photographs when compiling and updating maps; systematic accounting of changes in an area; editing topographic maps. The author discusses each of these areas in detail. References 3.

[147-11746]

TRAINING ENGINEERS TO INVESTIGATE NATURAL RESOURCES USING SPACE TECHNOLOGY

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOS"YEMKA
in Russian No 1, Jan-Feb 81 (manuscript received 23 Sep 80) pp 62-66

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[Abstract] Although specialists had the training to interpret the earliest space photographs, the advent of earth surveying outside the visual band required the education of a new generation of specialists with interdisciplinary training. Since 1976, the Moscow Institute of Engineers of Geodesy, Aerial Surveying and Cartography has offered a specialization in "Investigation of Natural Resources". The first class numbered 50 people. The course in this specialty that was instituted in 1978 lasts for 5 and a half years, for a total of 4,744 hours, broken down as follows: sociopolitical -- 542; mathematical -- 921; physics (including physics of the environment) -- 560; general technical and scientific -- 752; Earth sciences -- 526; specialized (surveying methods, information processing, space geodesy and so on) -- 780; other -- 663. Figures 1; references 3.

[147-11746]

LAUNCH TABLE

LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS in English or Russian various dates

[Summary]

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
18 Sep 81	Cosmos-1308	1,017 km	978 km	104.9 min	82.9
18 Sep 81	Cosmos-1309	282 km	225 km	89.2 min	82.3
21 Sep 81	Oreol-3	1,920 km	300 km	108.2 min	82.6
		(Soviet-French satellite launched as part of "Arkad" program to study earth's magnetosphere, ionosphere and aurora; data received by ground stations in USSR and France)			
23 Sep 81	Cosmos-1310	524 km	478 km	94.6 min	65.9
29 Sep 81	Cosmos-1311	521 km	470 km	94.5 min	83
30 Sep 81	Cosmos-1312	1,531 km	1,495 km	116 min	82.6
1 Oct 81	Cosmos-1313	314 km	214 km	89.5 min	70.4
9 Oct 81	Cosmos-1314	263 km	220 km	89 min	82.3
9 Oct 81	Raduga	35,900 km	--	24 hrs 02 min	0.4
		(Near-stationary circular orbit; communications satellite for transmission of telephone, telegraph and TV programs to stations in the "Orbita" network; international registration index: "Statsionar-3")			
14 Oct 81	Cosmos-1315	685 km	628 km	97.7 min	81.2
15 Oct 81	Cosmos-1316	407 km	215 km	90.5 min	70.3

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
17 Oct 81	Molniya-3	40,644 km	649 km	12 hrs 16 min	63
		(Communications satellite for long-range telephone, telegraph and TV broadcasts in the "Orbita network")			
30 Oct 81	Venera-13	(Interplanetary station scheduled to reach Venus in March 1982; carries French and Austrian as well as Soviet equipment)			
1 Nov 81	Cosmos-1317	40,165 km	636 km	12 hrs 06 min	62.9
3 Nov 81	Cosmos-1318	379 km	183 km	89.8 min	67.2
4 Nov 81	Venera-14	(Interplanetary station scheduled to reach Venus in March 1982)			
13 Nov 81	Cosmos-1319	400 km	216 km	90.4 min	70.4
17 Nov 81	Molniya-1	39,117 km	472 km	11 hrs 42 min	62.8
		(Communications satellite for long-range telephone, telegraph and TV broadcasts in the "Orbita" network)			
20 Nov 81	Bhaskara-2	(Indian satellite launched by Soviet booster rocket; equipped with visible and IR television cameras and a three-channel radiometer)			

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Dec. 28, 1981